PROCEEDINGS

OF

THE BOARD OF AGRICULTURE IN INDIA

HELD AT

PUSA

ON THE

7th February 1916, and following days

WITH APPENDICES

CALCUTTA
SUPERINTENDENT GOVERNMENT PRINTING, INDIA
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No. 4611A.

FROM

BERNARD COVENTRY, ESQ., C.I.E.,
Agricultural Adviser to the Government of India and Director, Agricultural Research Institute, Pusa,

To

THE SECRETARY TO THE GOVERNMENT OF INDIA,
DEPARTMENT OF REVENUE AND AGRICULTURE,
SIMLA.

PUSA, BIHAR, *the 31st March, 1916.*

SIR,

I have the honour to submit the Proceedings of the 9th Meeting of the Board of Agriculture in India, held at Pusa, on the 7th February, 1916, and following days. These Proceedings have been recorded by Mr. Wynne Sayer, Assistant to the Agricultural Adviser to the Government of India, who acted as Secretary. The Proceedings have been approved by the Board.

I have the honour to be,

SIR,

Your most obedient Servant,

B. COVENTRY,
Agricultural Adviser to the Government of India and Director, Agricultural Research Institute, Pusa.

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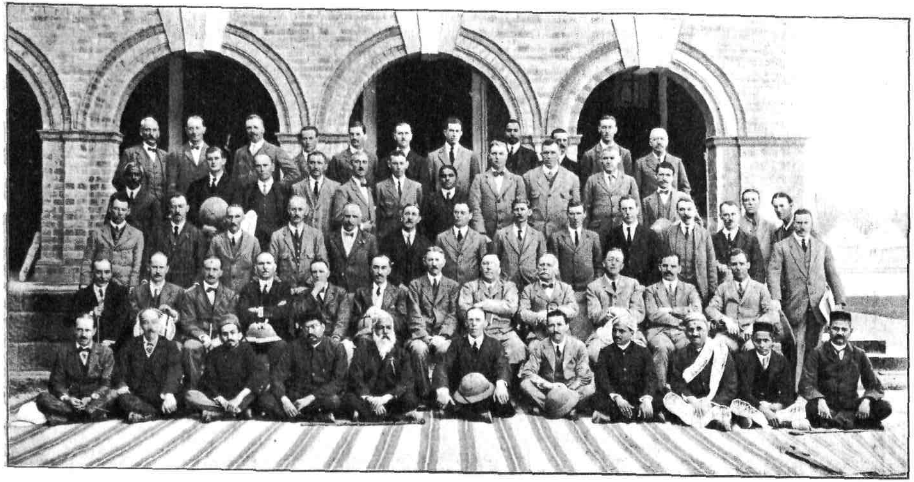

BOARD OF AGRICULTURE, FEBRUARY 1916.

The Ninth Meeting of the Board of Agriculture in India.

INTRODUCTORY.

1. The Ninth Meeting of the Board of Agriculture was held at Pusa, on the 7th February, 1916, and following days under the presidency of Mr. Bernard Coventry, C.I.E., Agricultural Adviser to the Government of India and Director, Agricultural Research Institute, Pusa.

MEMBERS.

The members present were :—

1. Bernard Coventry, C.I.E., Agricultural Adviser to the Government of India and Director, Agricultural Research Institute, Pusa. (President.)
2. M. Wynne Sayer, B.A., Assistant to the Agricultural Adviser to the Government of India, Pusa. (Secretary.)
3. E. J. Butler, M.B., F.L.S., Imperial Mycologist, Pusa.
4. A. Howard, C.I.E., M.A., Imperial Economic Botanist, Pusa.
5. S. Milligan, M.A., B.Sc., Imperial Agriculturist, Pusa.
6. C. M. Hutchinson, B.A., Imperial Agricultural Bacteriologist, Pusa.
7. T. Bainbrigge Fletcher, F.L.S., F.E.S., F.Z.S., Imperial Entomologist, Pusa.
8. J. N. Sen, M.A., Officiating Imperial Agricultural Chemist, Pusa.
9. A. W. Shilston, M.R.C.V.S., Officiating Imperial Bacteriologist, Imperial Bacteriological Laboratory, Muktesar.
10. H. C. Carter, M.B., Ch.B., Economic Botanist to the Botanical Survey of India, Calcutta.
11. J. R. Blackwood, M.A., I.C.S., Director of Agriculture, Bengal, Calcutta.
12. H. E. Annett, B.Sc., F.I.C., Agricultural Chemist, Bengal, Dacca.
13. Lieutenant-Colonel A. Smith, F.R.C.V.S., Principal, Bengal Veterinary College, Belgachia, Calcutta.
14. K. McLean, B.Sc., Deputy Director of Agriculture, Bengal, Dacca.
15. The Hon'ble Mr. H. R. C. Hailey, I.C.S., Director of Land Records and Agriculture, United Provinces, Lucknow.
16. C. W. Wilson, M.R.C.V.S., 2nd Superintendent, Civil Veterinary Department, United Provinces, Lucknow.
17. G. Clarke, F.I.C., Agricultural Chemist, United Provinces, Cawnpore.
18. C. A. H. Townsend, I.C.S., Director of Agriculture and Industries, Punjab, Lahore.
19. W. Roberts, B.Sc., Professor of Agriculture, Agricultural College, Lyallpur, Punjab.
20. Lieutenant-Colonel J. Farmer, F.R.C.V.S., Chief Superintendent, Civil Veterinary Department, Punjab, Lahore.
21. Colonel H. T. Pease, C.I.E., M.R.C.V.S., Principal, Punjab Veterinary College, Lahore.
22. G. F. Keatinge, C.I.E., I.C.S., Director of Agriculture, Bombay Presidency, Poona.
23. Harold H. Mann, D.Sc., Principal, Agricultural College, Poona.
24. Major G. K. Walker, C.I.E., F.R.C.V.S., Superintendent, Civil Veterinary Department, Bombay Presidency, Poona.
25. J. A. G. Cattell, Superintendent, Civil Veterinary Department, Sind, Baluchistan and Rajputana, Karachi.

26. D. T. Chadwick, M.A., I.C.S., Director of Agriculture, Madras.
27. G. R. Hilson, B.Sc., Deputy Director of Agriculture, Madras Presidency, Bellary.
28. F. Ware, M.R.C.V.S., Superintendent, Civil Veterinary Department, Madras.
29. C. A. Barber, Sc.D., Government Sugarcane Expert, Coimbatore.
30. R. W. B. C. Wood, M.A., Principal, Agricultural College, Coimbatore.
31. C. G. Leftwich, I.C.S., Director of Agriculture and Industries, Central Provinces and Berar, Nagpur.
32. D. Clouston, M.A., B.Sc., Deputy Director of Agriculture, Central Provinces, Southern Circle, Nagpur.
33. G. Milne, I.C.S., Director of Agriculture, Bihar and Orissa, Ranchi.
34. A. C. Dobbs, B.A., Deputy Director of Agriculture, Bihar and Orissa, Ranchi.
35. D. Quinlan, M.R.C.V.S., Superintendent, Civil Veterinary Department, Bihar and Orissa, Ranchi.
36. A. R. Edwards, I.C.S., Director of Land Records and Agriculture, Assam, Shillong.
37. A. A. Meggitt, B.Sc., Agricultural Chemist, Assam, Shillong.
38. W. Harris, M.R.C.V.S., Superintendent, Civil Veterinary Department, Assam, Shillong.
39. W. Robertson Brown, Agricultural Officer, North-West Frontier Province, Taru near Peshawar.
40. D. Meadows, M.R.C.V.S., Superintendent, Civil Veterinary Department, North-West Frontier Province, Rawalpindi.
41. Colonel G. H. Evans, C.I.E., M.R.C.V.S., Superintendent, Civil Veterinary Department, Burma, Rangoon.
42. A. McKerral, M.A., B.Sc., Deputy Director of Agriculture, Burma, Insein.
43. M. A. Sitole, B.A., M.R.A.C., Bar.-at-Law, Director of Agriculture and Industries, Baroda.
44. L. C. Coleman, M.A., Ph.D., Director of Agriculture, Mysore State, Bangalore.
45. N. Kunjan Pillai, M.A., B.Sc., Ph.D., Director of Agriculture, Travancore, Trivandrum.
46. R. D. Anstead, B.A., Deputy Director of Agriculture, Planting Districts, Bangalore.
47. G. D. Hope, Ph.D., B.Sc., Chief Scientific Officer, Indian Tea Association, Tocklai Experiment Station, P. O. Cinnamara.

VISITORS.

2. In addition, the following attended as visitors :—

1. The Hon'ble Mr. C. H. A. Hill, C.S.I., C.I.E., I.C.S., Member, Revenue and Agriculture Department, Government of India.
2. J. Mackenna, M.A., I.C.S., Deputy Commissioner, Myaungmya, Burma.
3. Colonel F. W. Hallowes, Director of Military Dairy Farms, Simla.
4. Mrs. G. L. C. Howard, M.A., K.-I.-H., Second Imperial Economic Botanist, Pusa.
5. F. J. F. Shaw, B.Sc., Second Imperial Mycologist, Pusa.
6. The Hon'ble Mr. L. F. Morshead, I.C.S., Commissioner, Tirhoot Division, Muzafferpur.
7. H. Maxwell-Lefroy, M.A., F.E.S., F.Z.S., Imperial Silk Specialist, Delhi.
8. R. S. Finlow, B.Sc., Fibre Expert to the Government of Bengal, Dacca.
9. J. H. Barnes, B.Sc., F.I.C., Principal, Agricultural College, Lyallpur, Punjab.

10. B. A. Collins, I.C.S., Registrar, Co-operative Societies, Bihar and Orissa, Ranchi.
11. W. Hulme, Sugar Engineer to the Government of India, Nawabganj, Bareilly.
12. H. R. Crosthwaite, Registrar, Co-operative Societies, Central Provinces and Berar, Nagpur.
13. W. Smith, Assistant Director, Military Dairy Farms, Poona.
14. Captain J. Matson, I.A., Assistant Director, Military Dairy Farms, Kasauli.
15. T. Gilbert, B.A., Deputy Director of Agriculture, Bombay Presidency, Dharwar.
16. G. Evans, M.A., Deputy Director of Agriculture, Northern Circle, Central Provinces, Jubbulpore.
17. R. G. Allan, M.A., Principal, Agricultural College, Nagpur.
18. R. J. D. Graham, M.A., B.Sc., Economic Botanist, Central Provinces, Nagpur.
19. F. J. Plymen, Agricultural Chemist, Central Provinces, Nagpur.
20. M. M. Mackenzie, Superintendent, Cattle-Breeding Farm, Sipaya.
21. Ram Gopal, M.A., M.R.A.C., Director of Agriculture, Kashmir.
22. R. Branford, M.R.C.V.S., Superintendent, Government Cattle Farm, Hissar.
23. T. Southwell, F.Z.S., Deputy Director of Fisheries, Bengal and Bihar and Orissa, Calcutta.
24. S. Higginbottom, M.A., B.Sc., Ewing Christian College, Allahabad.

PROGRAMME.

SUBJECTS DISCUSSED.

3. The programme before the Board consisted of the following subjects approved by the Government of India for discussion :—

I.—The Confirmation of the Proceedings of the last Meeting.

II.—The Programmes of work of the Imperial Department of Agriculture and of the Imperial Bacteriologist.

III.—The Programmes of work of the Provincial Agricultural and Veterinary Departments and of Native States' Departments of Agriculture.

IV.—The policy to be adopted in regard to the supply of cattle to foreign countries.

V.—The nomenclature of certain posts in the Imperial and Provincial Departments of Agriculture.

VI.—Soil denudation by rainfall, and drainage: conservation of soil moisture.

VII.—How the energies of the Veterinary Department can best be utilized in the control and check of cattle diseases and what means should be adopted for increasing the numbers of the subordinate staff as recommended at the last Meeting of the Board ?

VIII.—The Co-operative movement in its relation to Agriculture. How to organize the relations between the Co-operative Societies whether dealing with credit or some other branch of agricultural organization and the Agricultural Departments ? Whether there is any need to encourage Agricultural Associations in view of the special facilities possessed by Co-operative Societies for carrying on propaganda.

IX.—To what extent forest tracts act as harbours of rinderpest during the rainy season and what steps can be taken to combat the condition.

X.—The Indian Sugar Industry—Progress made in the Industry and improved methods.

XI.—Further consideration of Cattle-Breeding and Dairying in India.

XII.—The best agency for controlling cattle-breeding.

XIII.—Fisheries. Should the subject of Fisheries be dealt with by the Board of Agriculture in India, and, should the Fishery Experts of Madras, Bengal, Bihar and Orissa and the Punjab be made permanent members of the Board ?

PROCEEDINGS.

FIRST DAY.

Opening of Proceedings.

4. The first meeting of the Board was opened on Monday, the 7th February, 1916, by the Hon'ble Mr. C. H. A. Hill who, in his introductory speech, said :—

" I do not propose to detain you long on this the first occasion,—but I hope not the last,—of my being able to be present at part of the deliberations of the Board of Agriculture in India. As you are all aware, it is only a very short time since I have assumed charge of the Department of Agriculture and I come, therefore, to-day much more for the purpose of hearing your deliberations than for troubling you to listen to any remarks of mine. There are, however, one or two matters to which I should like to advert.

" In the first place, just as this is the first occasion on which I attend here, this, I fear, is also the last occasion on which we shall have, in his present position of Agricultural Adviser, the pleasure of Mr. Coventry's presence. I trust that it is very far from being the last occasion when he will attend, since, as you all know, though leaving us, he is not severing his connection with agriculture in India but is proceeding to organize a very interesting development in Central India. Mr. Coventry has administered the Pusa Institute with conspicuous success since the time of his appointment as Agricultural Adviser and the Government and all of you, as well, indeed, as India at large, owe Mr. Coventry a deep debt of gratitude for his devoted labours on behalf of the furtherance of the interests of agriculture in India. I am sure that you will all agree with me in this and, further, that you wish me, on your behalf, to tender him our warmest thanks for all he has done for us and our sincere hope for health and success in his new venture. Not only shall we be interested as spectators in his work in Central India, but we look forward with the greatest confidence to profiting very greatly by his labours there.

" It is to be regretted, as I said the other day, that the Hon'ble Sir Robert Carlyle, who has for so many years been associated with Pusa and the Board of Agriculture, should be absent to-day, and, personally, I feel very keenly the lack of his intimate knowledge not only of the subjects which will come up for discussion here but of the whole problem of agriculture in India. I can only hope that, with your assistance, I may, in the course of time, become familiarised with the problems and able to assist more directly in their solution than is the case at present.

" I do not propose to touch upon the subjects which are up for discussion at this meeting either in detail or generally. One of the most interesting from the point of view of the wider development of improved agricultural methods is No. 8, relating to the connection between the co-operative movement and agriculture. This has been up before you on previous occasions and interesting papers have been discussed and disposed of in the past. This year we have further the report of the Committee on Co-operation in India to assist us, and I only wish here to say that the remarks of that Committee in paragraphs 198-200 should be of considerable help in our deliberations. What we want to arrive at, of course, is a basis upon which we can co-ordinate the work of the agricultural and co-operative movements. The method suggested by the Committee on Co-operation may or may not be entirely applicable in all provinces and we shall have to wait for a considerable time before Local Governments are enabled to submit their views on that report and before the Government of India are able to pronounce upon their views when received. That, however, need not delay the bringing about of unified action between our agricultural employés and the Co-operative Committees throughout India. It will be for you to discuss and resolve upon how best to organize the relations between the two branches of the public service and to pronounce as to whether there is any need to encourage agricultural associations in view of the special facilities possessed by co-operative societies for carrying on propaganda. I do not wish to express any opinion upon the subject. All I would

urge upon you is to bear in mind throughout your discussions that it matters far less what means are employed to bring about co-operation than to secure that such co-operation is brought about. It is highly probable that, in different provinces of India, different methods may commend themselves and there is much advantage in diversity of procedure since we then get varied experience to guide us. What I think is really essential is that every representative of the Agricultural Department, from the Directors downwards, in each province, however the Department is organized, should realize that it is an essential part of his duty, and that his work will be judged by the degree in which he discharges that part of his duty, to see that no effort is spared to work with not only the Registrars of the Co-operative Societies, but, wherever opportunity offers, with the co-operative societies and their officials themselves. Much loss of efficiency in India is attributable to excessive adherence to official procedure. There is no branch of the Service in which such an attitude of mind can do more harm than in the operations designed to facilitate the improvement, all over India, of agricultural methods, and Directors of Agriculture will do well to inculcate upon their subordinates that official etiquette is of far less value in their eyes than the bringing about of practical results.

"The other subject to which I wish to refer for one moment is the question of cattle-breeding and dairying in India. The Agricultural Adviser's note, based upon this Board's deliberations at Coimbatore, outlines a scheme for cattle-breeding and setting apart certain farms for the purpose. There is some risk, I venture to think, that, unless great care is observed, some confusion may arise in regard to what are essentially in India separate branches of the same subject. Over large tracts of India, in fact over I believe most of the country, cattle-breeding, excluding buffaloes, is primarily not for dairying purposes at all but for the production of bullocks for agricultural purposes. Any schemes for the improvement of the breeding of cattle should bear this strictly in mind. The problem of improving the breeding of plough cattle is in some respects entirely distinct from the problem of improving the milking qualities of Indian cattle. This distinction is implied in paragraph 5 of the Agricultural Adviser's memorandum to which I have alluded and the suggestion therein made is that the preservation and improvement of existing indigenous breeds of plough cattle is primarily a matter for the Provincial Governments, while the memorandum deals solely with the dairying side of the question. Such reference as is made to crossing with imported stock is specifically with reference to this side of the question.

"I desire to endorse the Agricultural Adviser's remark that the views of this Board on the other side of the question, *viz.*, the improvement of the indigenous strains of plough cattle would probably be of use to Local Governments. I would go further and suggest to you the feasibility of taking this question up for discussion to see whether you cannot suggest a scheme for cattle breeding distinct from, but supplementary to, that dealt with in Mr. Coventry's memorandum. There would have to be co-operation between the Agricultural, Co-operative and Veterinary Departments and also, I suggest, with the Army Remount Department. The last-named Department has acquired, in the matter of breeding, an experience which should be of the greatest value to you—an experience which should not be lost. There is a close analogy between horse and cattle-breeding, and the Army Remount Department have been engaged on experiments of all kinds with horse-breeding for years past. Should you be enabled to outline or elaborate suggestions for improvements in the breeding of plough cattle, it seems to me that it will be a great advantage at the next meeting of this Board if we invite an officer of the Remount Department to be present.

"The other day, when opening the informal conference on Agricultural Education, I implied that all our deliberations aiming at an improvement in the methods of agriculture in India should be formulated not only with reference to the immediate future but with reference to the permanent development of the prosperity of the country. We must, in dealing not only with questions relating to agricultural education but also with questions relating to agriculture itself, avoid at all hazards the temptation to resort to empirical methods for the sake of obtaining immediate results. We must, in fact, take long views, and I refer to this matter here chiefly for this reason, that I wish to emphasize that it is only through the creation of a body of Indian agriculturists throughout the country, who shall not

only be qualified to till the soil efficiently and economically, but who shall have developed a spirit of inquiry and an intelligent desire to keep abreast of the times, that we shall really achieve the results which we aspire to. India, owing to the caste system, is a country which presents singular difficulties to any reformer in any department of life, and not least so in reference to the improvements in the staple industry of the country. It is only the agriculturist who regards agriculture as a pursuit of dignity and worthy of the industry of his own hands. Consequently, it is essential to aim, in the last resort, not only, as I have said, at developing in the immediate future industrious and skilful agriculturists with reference to the science of agriculture at its present stage, but to induce gradually a certain number of members of the agricultural community of the country to consent to take up the higher branches of agricultural science. It is by this means only that we shall be able to graft upon the proceedings of the Agricultural Department an indigenous agency qualified and able to assimilate progressively the teachings which we are able to impart. The Imperial Agricultural Department must in the nature of things always be a small one. The Provincial Agricultural Departments also, within their provinces, are a small centre for the development of agricultural science and practice. Neither the Imperial Department here established at Pusa nor the Provincial Departments will have fully discharged their duties unless and until they are working *with* and *through*, as well as on behalf of, the agriculturists of the country. One reason why I have emphasized, perhaps unduly, the subject numbered 8 which will come up for discussion, relating to the connection between the co-operative movement and agriculture, is that the co-operative movement affords the Agricultural Department an immediate method of initiating a procedure which is calculated, I think, to bring about an active realization of the propositions I have just ventured to lay before you. I am sure that Government can rely on all of you to approach all the subjects connected with agricultural improvement and development from the wider standpoint and to work together with a view to arriving at the realization of the high ideals which I know animate all of you."

5. The President gratefully acknowledged the kind references to his work by the Hon'ble Mr. Hill and said that though he was leaving Pusa, yet he would be connected with the work of agriculture in India as before. He then addressed the meeting and said :—

" Before proceeding with our business I desire to offer you all a hearty welcome to Pusa and to this the ninth meeting of the Board of Agriculture. I also particularly welcome our Hon'ble Member of Council—Mr. C. H. A. Hill, who has taken the trouble to tear himself away from his onerous duties, in order to be present at this meeting and to make your acquaintances.

" It is with intense regret that I have to mention the death of Lieutenant-Colonel Holmes, the Imperial Bacteriologist, which occurred in the month of February of last year. The work he has contributed to Veterinary Science has been considerable and its importance was recognized by his being given the Steel Memorial Medal in 1912, the highest reward obtainable in his profession. Government too recognized his merit by conferring upon him the C.I.E. in the following year and shortly before his death he had been raised to the status of Lieutenant-Colonel by special orders of the Secretary of State. By his sudden and untimely death we have all lost a distinguished colleague and the Government a most able and energetic officer.

" Another loss the Department has sustained is in the retirement of Dr. Leather who has accepted a commission in the 3rd Garrison Battalion of the Cheshire Regiment in England and is henceforth to be known as Major Leather. While we must all sincerely feel the blank which his absence from amongst us occasions and do not forget the good and solid work he has done for Government during a service of 25 years, we must congratulate him on his promotion and the attainment of the great desire he always possessed to serve his country as a soldier.

" Since your last meeting at Coimbatore the following additions have been made to the superior staff of the Indian Agricultural Service. The posts of Second Imperial Economic Botanist and Second Imperial Mycologist have been created at Pusa to which Mrs. Howard and Mr. Shaw have been appointed respectively.

"A second post of Deputy Director of Agriculture has been made in Bengal to whom Mr. McLean has been appointed. Two additional Deputy Directors of

Agriculture have been sanctioned in Bihar and Orissa and are held by Messrs. Dobbs and Sethi. One additional post of Deputy Director of Agriculture has been made in the Punjab to which Mr. Faulkner has been appointed. Besides these the following posts have been sanctioned by the Secretary of State which however are for the moment vacant chiefly owing to the difficulty of getting suitable recruits during the war; two additional Assistant Directors of Agriculture in the Central Provinces, one Second Economic Botanist in Bombay, four additional Deputy Directors of Agriculture and one Superintendent of the Cinchona Plantations in Madras, one Second Deputy Director of Agriculture in Assam, a third Deputy Director of Agriculture in Burma, and a Deputy Director of Agriculture for the Andamans making a total of 16 new posts. This brings the total number of officers in the Indian Agricultural Service to 86. While we may congratulate ourselves on the progress we are making, we must look forward to still further expansion if our work is to have a determined influence in raising the standard of agriculture. Especially have we need of more Deputy Directors of Agriculture for not only through their work in the field are improvements made, but they are the channel by which the application of all scientific progress must reach the cultivator. Just as the Collector or the Deputy Commissioner is the *mai bap* and the cherisher of the poor in his District, so has the Deputy Director of Agriculture a similar destiny and I look forward to the day when he will be the chief instrument under Government for the upraising of the people and adding to their material progress.

"In the following instances has action been taken on the Resolutions of the last meeting of the Board. With regard to the recommendations of the Board that the establishment of cattle insurance on co-operative lines should be undertaken, while quite a large number of co-operative cattle insurance societies have already been started in Burma. four such societies have been registered as an experimental measure in the Mainpuri District of the United Provinces.

"As regards Fruit Culture, some of the Provinces, *e.g.*, Bombay and the Central Provinces are engaged in surveying suitable localities for fruit growing, and the testing of varieties. The Bombay Department of Agriculture has established fruit orchards at the Agricultural Stations at Dharwar, Gokak, Dhulia and Dohad and that of the Central Provinces at Tharsa. The United Provinces too have their eye on developing fruit culture in Kumaon.

"Besides this there are well established experimental fruit stations at Pusa, Quetta, Saharanpur, Peshawar, and in the Punjab (for dates), Sind and Assam.

"On the subject of Soil Denudation and Drainage and the Conservation of Soil Moisture, further information has been collected as requested at the last meeting of the Board. This subject is to be considered again this year and it is hoped the Board will be able to frame recommendations on these important matters.

"Important work is being carried out in Bengal, Bihar and Orissa, Assam, Central Provinces, Madras and Burma on rice, a subject which occupied the attention of the last Board.

"As regards Agricultural Education, the colleges at Coimbatore, Lyallpur, Cawnpur and Nagpur have given effect to the proposals of the last Board to add a preliminary course to the curriculum of Agricultural Colleges, and the Sabour College is about to do the same.

"On the proposal that the present pay and prospects of the subordinate staff of the Departments in most of the Provinces were not sufficiently attractive to induce young men to take up the College Course and the recommendation that an increase should be made where necessary, the Departments of Agriculture in Madras and the Punjab have effected a general improvement in the pay and prospects of their subordinate staffs. The Board also supported the expressions of willingness on the part of the Agricultural Department to confer with the Education Department and discuss the sympathetic co-operation of the two departments in adapting rural education to rural needs. A joint committee of agricultural and educational officers has been sitting at Pusa during the past three days under the presidency of the Honourable Member, Mr. C. H. A. Hill, the conclusions from which will doubtless be communicated in due course.

"I will now briefly pass in review the subjects for discussion at the present meeting. Subjects I, II and III require no remarks from me at this stage.

"Subject IV has reference to the policy to be adopted in regard to the supply of cattle to foreign countries. This subject appears to carry two aspects, *viz.*, the beneficial and the detrimental. The export of cattle may be said to be beneficial in so far as it stimulates the production of better cattle, adds to the profits of the breeder and generally raises the standard of the breeding industry. The animal breeding industry in England would scarcely have reached the pre-eminent position it has enjoyed for many years if it had not been due to the fact that it is the great supplier of high bred stock to temperate countries. Might not India take up a similar position for the tropics? On the other hand, there is evidence to show that the practice in this country may under some circumstances be detrimental. In Madras, for instance, very large numbers of cattle are exported which is having a harmful effect and is tending to cause an undue drain on the cattle in parts of the presidency. In this case they are generally exported, I understand, not so much for breeding purposes, but to supply the demand for draft cattle and cows to Java, Ceylon and the Malay States. Where cattle are exported for breeding purposes only and sent to distant countries such as Japan, West Indies, Africa and South America, I believe not only that no harm occurs, but that on the contrary the practice affords an inducement to breeders to be more careful with their breeding and stimulates the production of better stock. The only unsatisfactory point I have been able to discover in regard to this aspect of the case is that the Indian breeder has not become sufficiently conscious of the true value of a well-bred bull, and usually parts with it at a price which represents half its value. However that may be, the differences in the effects which result from this trade in the export of cattle, some of them being of advantage, others not, indicate that there is a need for our looking into the matter and for the exercise of control and discrimination in the working of the trade. The Government of India have therefore thought it proper to invite a discussion on the subject and solicit your advice.

"Subject V deals with the nomenclature of certain posts in the Agricultural Departments. A singular want of uniformity exists in different provinces in posts carrying practically the same duties and emoluments. Also in some cases a designation is given in one province to members of the Provincial Service which in another is reserved for members of the Indian Agricultural Service, such as the designations of Assistant Director and Supernumerary Agriculturist.

"In the Provincial Service various designations are used to denote more or less the same duties such as Assistant Director, Divisional Inspector, Farm Superintendent, Extra Assistant Director, Agricultural Supervisor, Travelling Inspector and the like. The want of uniformity is due no doubt to Provincial Departments developing on their own lines. There is no intention to check this, but it is obviously desirable that in a department in which so much interest is taken by the public and for other reasons, designations of posts performing more or less the same kind of work, should, you will probably agree with me, maintain a certain degree of uniformity. The question will also be put to you whether the Board can recommend a nomenclature for the Provincial Service which can indicate a relation to posts in the Imperial Service and express the intention to give, during leave vacancies, opportunities to members of the Provincial Service to prove their fitness for permanent promotion. The Government of India therefore desire to have your recommendations on these questions.

"Subject VI refers to Soil Denudation by Rainfall, and Drainage, and the Conservation of Soil Moisture. I need not impress upon you the great importance of these subjects. They speak for themselves. They were before you at the last Board but as the information then supplied was insufficient to enable recommendations to be framed, consideration has been postponed till this meeting, the information required being now available.

"The next point is how the energies of the Veterinary Department can best be utilized in the control and check of cattle diseases and what means should be adopted for increasing the numbers of the subordinate staff as recommended at the last meeting of the Board (Subject VII).

"Gentlemen, there are three departments of the State which are most intimately concerned in the immediate welfare of the cultivator. They are the Agricultural Department, the Co-operative Department and the Veterinary Department. While the first two are in their infancy and are still in the throes of research and experiment, the Veterinary Department in India is a time-honoured institution

whose research is far ahead of its development. You have in the discoveries on rinderpest, hæmorrhagic septicæmia, and other diseases, effective means for the control of animal diseases and all you require to do is to develop your organization and to utilize the means ready at your disposal. The question before you is how this can best be done. I do not suppose there is any one who would question the importance of the work of the Veterinary Department in this country. As I have already said it is intimately concerned with the welfare of the cultivating class. The bullock is a necessary and integral part of the cultivator's stock in trade and calls for the greatest portion of his working capital. The price of cattle has gone up enormously of recent years and if by an epidemic of rinderpest he is deprived of his newly acquired bullocks, the financial shock to him is as great as any that can be conceived. It is still greater if the loss is repeated, as it often is, within a short period. He may be led to the verge of bankruptcy or driven irretrievably into the hands of the money-lender. I do not think I am putting the case too strongly, for I am credibly informed that there are places in India where the cattle population is almost completely destroyed every 5 or 6 years. The number of outbreaks which the Veterinary Department is able to attend to is, I believe, in some provinces very low. I have only been able to get the figures from one province, *viz.*, Bihar and Orissa. In 1913-14 out of 1,525 recorded outbreaks of rinderpest only 369 or 24·1 per cent. were attended to. In the previous year the figure was only 15·6 per cent. This has reference to recorded outbreaks. There must be a considerable number which are not recorded. Some provinces, I know, can show greater efficiency than this. But the question is whether your efficiency is on a sufficiently high level considering the importance of the subject and whether you have any recommendations to make for improvements. The Veterinary Department is, I am glad to see, very strongly represented and I feel sure the officers of that Department will give the subject the careful attention it deserves. I should not omit to say that in a form the matter was brought up for consideration at the last Board but the terms of reference confined the discussion to a comparatively side issue, on the question of the use of prophylactic measures as a basis for cattle insurance. To-day you are invited to approach the subject from a wider point of view and I should like to say that this has been done at the request of an officer of the Veterinary Department who has suggested its recommendation on the wider issue. The Board too, at its last meeting recommended an increase in the staff of the Department and we should like to know in what way you recommend this should be done.

"There are three other subjects on the agenda in which Veterinary Officers are interested, *viz.*, the extent to which forest tracts act as harbours of rinderpest, cattle-breeding and dairying and the best agency for controlling cattle-breeding. The last has been added to the agenda at the request of the Government of India who desire to have the opinion of the Board as to whether cattle-breeding should be controlled and directed by the Veterinary or the Agricultural Department. There appears to be a divergence of views between provinces in this matter and a pronouncement by the Board would be welcome. On the subject of cattle-breeding and dairying I shall have something to say later on.

"I now come to Subject VIII of the agenda—The Co-operative movement in its relation to Agriculture. How to organize the relations between the co-operative societies whether dealing with credit or some other branch of agricultural organization, and the Agricultural Departments? Whether there is any need to encourage agricultural associations in view of the facilities possessed by co-operative societies for carrying on propaganda. We are very fortunate indeed, gentlemen, to have secured the presence at this meeting of Messrs. Collins and Crosthwaite, the Registrars of Co-Operative Societies for Bihar, and Central Provinces respectively. I fear that without them there was a chance of our discussion on this important matter being to a certain extent barren. We therefore most gladly welcome their assistance and I have little doubt that with their expert advice to help us we shall succeed in placing Co-operation for the spread of agricultural improvements on approved lines.

"I should like to give you a few references to the subject of Co-operation as it affects Agriculture which may be of use to you.

"Sir Robert Carlyle in his speech at the close of the last meeting of the Board, in pointing out the important part Co-operation is likely to play in the spread of

agricultural improvements, said 'I would add one word of warning, and that is that co-operative societies should not be used for experimental purposes and the functions allotted to them in connection with agriculture should be of a very strictly defined character.'

"Also the Report of the Committee on Co-operation in India, para. 13, says—'Most forms of agricultural non-credit societies, and especially those for the supply of seed and implements, can in our opinion best be combined with credit societies. It is, we think, in the use of credit societies for distributing improved seed and implements, and in the general supervision and development of non-credit societies, that the help of the Agricultural Department can most usefully be afforded

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Provided that it uses the societies not for experimenting in new processes but strictly for popularising proved improvements, we think that nothing but good can be expected from the assistance of the Agricultural Department.'

"I should also like to read you extracts of a letter I received last year from Mr. Henry Wolff, the distinguished promoter of co-operation in Europe as it directly bears on our subject.

After acknowledging the "4th Report of the Board of Agriculture on the Introduction of Improvements into Indian Agriculture," which I had sent him he goes on to say, 'My impression is that there is a grand opportunity for the improvement of agriculture, much needed as it is, in India by Co-operation. And I am thankful to see from the annual report of the several Registrars with what earnestness and eagerness people are turning their thoughts towards that problem.

'If you will allow me to offer one remark by way of caution, it is this—that you appear in danger of mixing up co-operative credit with too many other forms of co-operation. There is danger in this, and I apprehend disappointment. Of all forms of co-operation, credit is that which, in a permanent state of things, should stand by itself—more particularly when liability is unlimited which I hold to be permissible only in co-operation for credit.

'In a small village society, or as a start, where there would be difficulty about entering upon a new departure on other lines—which I take to be in the main your case—I hold it not only to be permissible but proper for the little credit society to take the matter up pioneeringly. Under such conditions business is likely to be circumscribed and very easy to supervise and control; and liability is not likely to overlap. The men who combine for purposes of credit are likely to be the same who combine also for the purchase of manures or implements. Otherwise, obviously, it would not be fair to make the credit co-operator bear any loss occurring in other branches of business.

'But once transactions become at all considerable and the various forms of co-operation overlap or fail to cover one or other, there is serious danger in combination.

'That applies to credit distribution and production, sale, and so on which will blend together. And for them liability should be limited.

'If I am not presuming—which I should not like to be thought that I am doing—I venture to hope that the members of your committee among whom I observe that opinion on the point is divided—will give consideration to this argument.'

"You will see that these views, authoritative though they be, do not exactly coincide. The Report on Co-operation would seem to indicate that the use of credit societies for non-credit purposes is a good thing, while Mr. Wolff is directly opposed to this except when done as he says 'pioneeringly.' I will not attempt to anticipate the decision of the Board on this important question. I merely place these views before you so that you may give full consideration to the arguments which they raise.

"On the subject of the Indian Sugar Industry I need not detain you. It has been placed on the list in order that you may report progress and we may therefore await the report of the Committee which will be appointed to deal with it.

"I now come to the subjects of Cattle-breeding and Dairying (Subject XI). They were considered at the last meeting of the Board. The recommendations of the Board have received the sympathetic consideration of the Government

but conscious as they are of the immensity and importance of the problems of cattle breeding and dairying in this country they think that a further discussion would be an advantage before definite action is taken. In order to facilitate discussion and to concentrate the attention of the Board on one or two of the important points, I have drawn up a memorandum summarizing the situation as we, at present, find it and particularly placing before you for consideration a scheme which is not intended to be exhaustive but which is meant to be a starting point or a nucleus of more extensive measures. I will endeavour briefly to explain the scheme.

"After the meeting of the last Board a note was prepared by Messrs. Milligan and Smith which purported to give expression to the views of the Board. This was forwarded to Government along with the proceedings. Since then discussions have taken place with officers of the Agricultural Department and Military Dairies which have made it possible to place before you a partial scheme for cattle breeding and dairying. But before carrying the matter any further it is felt desirable to have the views of the Board. I should like to say that in preparing my memorandum I have made free use of Messrs. Milligan and Smith's recommendations, and that I am also further indebted to a considerable amount of assistance from Colonel Hallowes, Captain Matson and Mr. Smith. The scheme suggested is briefly this. That an Imperial Expert Breeding and Dairying Officer should be added to the Imperial Department of Agriculture. His function would be to organize and control special breeding and dairying operations, to supervise dairy schools and dairy instruction, and generally to advise and assist Local Governments, provincial officers, Military Dairy Farms, Municipalities and private institutions on cattle breeding and dairying. In addition to this appointment it is suggested that a Chemist should be appointed to work out the value of food stuffs and the digestive capacity of Indian animals. At the last Board you did not recommend this work being taken up at this stage, but the Military Dairies say there is great need for this work if feeding is to be done on the most economical lines. In deference to that view the point is to be placed before you again for reconsideration. It is also considered necessary to adopt measures for the prevention of rinderpest and other diseases amongst imported and cross-bred cattle which will be used in the scheme and also to protect all stock, country-bred as well as half-bred, and it is suggested to you that the Muktesar staff should undertake this work.

"In order to carry out the work it is proposed that the assistance of the Military Dairies should be invoked and that to commence with 7 farms with about 1,000 head of pure indigenous strain should be used for the production of pedigree, from which some 300 bulls of 3½ years old would be obtained yearly for distribution to provinces. There would similarly be an arrangement for the production of 200 young buffalo bulls. It is also suggested that there should be at Amballa and Bangalore breeding experiments in crossing with imported blood with the primary object of increasing the yield of milk and that incidentally an endeavour might be made in the experiment to fix a type of dual purpose animal suitable for the country.

"The scheme too includes provision for dairying and dairy instruction. It is proposed that dairy schools should be erected at Bangalore, Poona and Lucknow, giving a two years' course to include practical dairying and the handling of cattle with elementary scientific instruction in cognate subjects. There would also be special short courses. The determination of food values and the immunization of cattle as I have already mentioned also come within the scheme. It must be understood that it is put before you as a partial scheme, a suggested contribution on the part of the Imperial Government, which would have to be complemented by provincial effort. The proposal does not come to you from the Government of India and I am not in a position to say they are prepared to accept it if supported by the Board, but it is an attempt on my part to crystallize the ideas which the Board had at its last meeting with a view of sending up definite proposals for the consideration of Government. It then does not include such important questions as the protection and amelioration of the existing indigenous cattle breeding industry, the preservation and multiplication of the existing types of Indian cattle and the general questions of fodder supply and grazing. It is felt that they present problems of so local a character that the initiative can scarcely be undertaken by the Imperial Government and therefore it is best to leave these aspects to Provincial Governments to deal with. You

will however be given the opportunity of considering and making recommendations on this also.

"I have said enough to give you an idea of the subject before you. I confidently expect that the Board will, on this occasion, be able to frame recommendations of such a character as to lay solid foundations for the improvement of cattle breeding and milk supply. I am glad to be able to say that Captain Matson and Mr. Smith are here to help us with their expert knowledge and experience, and I hope Colonel Hallowes will be able to come too and be present at the general discussion.

"The last Subject XIII deals with Fisheries. The question will be put to you whether Fisheries is a suitable subject to be dealt with by the Board and whether the Provincial Fishery Experts should be made members of the Board. The reason for the reference is that two views have been expressed on the point. One holds that fisheries can be of no interest to members of the Board and that no advantage is likely to be gained by referring the subject to them. The other view holds that fisheries, especially land fisheries, concern the land, the landlord and the tenant which come into touch with the Agricultural Department and that the meetings of the Board are likely to afford a suitable atmosphere for the discussion of the problems. The Government of India will therefore be glad to receive your views and recommendations on the subject."

SUBJECT I.—CONFIRMATION OF PROCEEDINGS OF THE LAST MEETING.

6. After **the Proceedings of the last Meeting were confirmed,** committees were appointed to deal with Subjects II to XII and the Board adjourned for the Committees to deliberate.

FOURTH DAY.

7. The second meeting was held on the 10th February 1916, when Subjects II, III (Agricultural and Veterinary), IV, VII, IX, XII and VIII were discussed.

The Committee on Subjects II and III (Agriculture) consisted of Dr. Butler (Chairman), Messrs. Dobbs, Barnes, Hutchinson, Plymen, Roberts and Dr. Kunjan Pillai.

SUBJECT II.—(AGRICULTURE): PROGRAMME OF WORK OF THE IMPERIAL DEPARTMENT.

8. The terms of reference were :—

To examine how far the several programmes meet the requirements of the Provinces and of the other Imperial officers.

At the request of the President, Dr. Butler read the following report of the Committee :—

"The Committee observe that the recommendations of the Board of 1913,* *viz.*, that the programmes should show in brief the connection between the proposed lines of work and the results obtained in the past, have not been carried out in preparing the programmes of the Imperial Department and consider that they should be revised in accordance with these recommendations. Subject to this the programmes are approved."

* Page 18, para. 10 of the Proceedings.

The report was adopted after the following discussion :—

Mr. Keatinge suggested that some list of rules for the preparation of programmes should be drawn up and circulated for the guidance of members as rules changed from time to time. Dr. Butler agreed with Mr. Keatinge. Mr. Fletcher enquired if any limit could be set to the size of the programmes as, if one had to state what had been and was going to be done, it would be very lengthy. The President, therefore, asked Dr. Butler whether this point had been considered. Dr. Butler then referred to rules as set out by Committee A of the Board of Agriculture, 1910, and also read remarks made by the Board of 1913. Mr. Howard, being asked by the President for remarks, said that as the Pusa officers all publish their reports each year by Christmas in ample time for the Board and as some

trouble is taken in preparing these reports, he was inclined to think that all the information required by the Board is supplied therein and they should be referred to, when necessary. In his opinion any carrying out of the Board's rules was inadvisable. Mr. Meggitt agreed with Mr. Howard and he observed that the same argument applied to the Provincial officers, but they were bound by certain rules, and if all annual reports had to be read it would entail great work on the Committee. Mr. Milligan suggested that the procedure of appointing Committees to consider programmes should be dropped with which Mr. Howard agreed. Dr. Coleman suggested that programmes should be dropped. Thereupon, Mr. Howard said that it was not advisable to drop programmes, but as a preliminary the Committees could be dropped. Dr. Coleman then pointed out that programmes serve no useful purpose as, often things drop out of them, which are never noticed by the Board. In his opinion it was a waste of time to prepare programmes.

Dr. Butler supported Dr. Coleman and added that in his case programmes do not show at all what work was to be done. Mr. Leftwich supported Dr. Butler and said that he could see no value in programmes which could be changed in the Central Provinces without the Board noticing it, and he doubted if any one referred to them. He, therefore, was in favour of the proposal that the programmes should be dropped. Dr. Mann pointed out that programmes indicated work done and also who was working on particular subjects. They served to prevent overlapping and the officers concerned could receive useful advice from Board. So the small amount of time taken up in the preparation of programmes is not thrown away. Mr. Barnes suggested the substitution, for the Committee's consideration, of annual reports. Dr. Butler pointed out that the suggestion to drop programmes had been made at the Coimbatore Meeting, but no Committee could report on annual reports in the time at its disposal. Mr. Leftwich suggested as a remedy that each member of Committee should take his branch of the report.

Mr. Milligan suggested that as the reports of this Committee are practically of no use, programmes specially prepared for the Board be dropped.

Dr. Coleman then proposed **the following resolution** :—

"That it be recommended to the Government of India that the submission of programmes, both Provincial and Imperial, to the Board be definitely dropped."

The President having put this proposal to vote it **was carried** by a majority of 32 to 4.

Mr. Barnes then proposed that the consideration of programmes submitted to the Board be dropped and a review of annual reports should be substituted. Mr. Milne seconded it. Referring to the difficulty of getting through the reports in the short time at its disposal, Mr. Barnes said that a Committee could be appointed ahead of the Board; the President thereupon remarked that he would be exceeding his powers if he did this, but thought that if Mr. Barnes suggested a Provisional Committee it would be all right. Dr. Butler thought it was impossible to deal with the reports even if the Committee were appointed six months before the Board. Dr. Coleman pointed out another difficulty, *viz.*, that annual reports do not come out in many cases till long after the Board meets. Mr. Barnes' proposal was put to the Meeting and lost by 20 votes to 6.

SUBJECT III.—(AGRICULTURE): THE PROGRAMMES OF WORK OF PROVINCIAL AND NATIVE STATES' DEPARTMENTS.

9. The terms of reference were :—

To consider how far the programmes of the several Provincial and Native States' Department; meet the requirements of the Imperial officers and of the other Provinces and States.

Dr. Butler read the report of the Committee which was as follows :—

"The Committee regret to notice that the suggestion approved by the Board at the last meeting, that where the officers of a department are engaged in teaching, this should be indicated either in the Director's summary or in the Specialists' programmes has not been followed in several cases.

They desire to suggest that when any material change is made in the curriculum of an Agricultural College, the Principal should furnish a report to the next meeting of the Board.

They regret to observe that in the Punjab and Burma the names of the officers responsible for the programmes are not given. They consider that it should always be made clear who is actually in charge of each section of the work.

They are of opinion that the use of local terms (such as those specifying different kinds of soils in Bombay and crops in the United Provinces) which are not likely to be understood in other Provinces, should be avoided as far as possible in preparing programmes.

In view of the difficulty in dealing with the large mass of papers which the Committee has to examine, they desire to make a suggestion that the names of members whom it is proposed to invite to serve on committees should be circulated some time in advance of the meeting.

(1) *Bengal.*—The Committee are of opinion that there is a much larger number of demonstrators and the like than the present superior staff can adequately control. They consider that the question of strengthening the superior staff of this Department is one of some urgency, in view of the importance of agriculture in Bengal and of the apparent lack of clear aims in the direction of the work.

The Committee further recommend that demonstrations as well as experiments should, until a larger superior staff is available, be concentrated on a few areas where they can be closely controlled, and that demonstrational work should be restricted to improvements the value of which has been established by experiment. It is assumed that no important new departure will be made in the sericultural work until the report of the Imperial Sericultural Expert shall have been received.

(2) *Bihar and Orissa.*—Reference is made in the programme of the Deputy Director of Agriculture, Orissa Division, to an investigation of the water requirements of rice. The Committee consider that in view of the importance of this matter and the experimental difficulties likely to be encountered, the methods which it is proposed to adopt should have been indicated.

(3) *United Provinces.*—The Committee consider that the method of improvement by selection of American cotton at Cawnpur referred to in the programme of the Deputy Director, Central Circle, should be more definitely explained, and that ordinary field selection without separation of different strains is not likely to lead to any permanent results.

(4) *Punjab.*—The programme of the Punjab is approved.

(5) *Bombay.*—In the absence of a sufficiently detailed account of the work in progress or projected, the Committee are unable to offer any comments on the programme of the Agricultural Engineer.

(6) *Madras.*—The programme of Madras is approved.

(7) *Central Provinces and Berar.*—The programme of the Central Provinces and Berar is approved.

(8) *Assam.*—The Committee regret to note that the absence of laboratory accommodation continues to hamper the work of the Agricultural Chemist.

(9) *Burma.*—The programme of Burma is approved.

(10) *North-West Frontier Province.*—The programme of the North-West Frontier Province is approved.

(11) *Mysore.*—The programme of Mysore is approved.

(12) *Kashmir.*—The Committee regret to understand that no addition to the staff of this Department has been made since the last meeting of the Board.

It is suggested that the programme might with advantage indicate the major lines of work in progress or contemplated.

(13) *Travancore.*—The programme of Travancore is approved.

(14) *Baroda.*—The Programme of Baroda is approved."

The President having called for remarks, Mr. Wood remarked that the Committee have alluded to the difficulty of examining programmes without sufficient notice. He, therefore, suggested that a list of subjects for the Board's discussion should be circulated to all Directors of Agriculture and moved **a resolution that**—

"The Board recommends that the Directors of Agriculture should be asked to state on which Committees they prefer their men to serve and that the Agricultural Adviser to the Government of India should therefrom appoint provisional committees, as long as possible before the Board meets and communicate them to the Provinces." RES.

This was seconded by Mr. Chadwick, and **was carried** by 17 votes to 3.

Mr. Milne said he had not been able to find out what had been done with rice in Burma and so had not yet settled their own line of work on paddy.

The report of the Committee **was accepted** by the Board.

10. The Board then proceeded to consider Subjects II and III (Veterinary).

The Committee on these subjects consisted of the Hon'ble Mr. Hailey (Chairman), Colonel Pease, Lieutenant-Colonel Smith, Major Walker, Messrs. Shilston and Ware.

SUBJECT II.—(VETERINARY): THE PROGRAMME OF WORK OF THE IMPERIAL BACTERIOLOGIST, MUKTESAR.

11. The terms of reference were :—

To examine how far the programme meets the requirements of the Provinces.

The Hon'ble Mr. Hailey read the report of the Committee which was as follows :—

"The Committee is of opinion that having regard to the strength of the staff at the disposal of the Imperial Bacteriologist, the programme is fully adequate.

They would, however, suggest that if possible an enquiry should be made into the vitality of the rinderpest virus outside the body under varying conditions.

The point is of importance to cattle insurance societies and to cattle owners generally to determine the period within which it would be safe to replace cattle after an outbreak of the disease."

Mr. Shilston said that he would adopt the recommendation of the Committee. He had made some observations on the subject of the recommendation and proposed to carry it out.

The report was accepted by the Board.

SUBJECT III.—(VETERINARY): THE PROGRAMMES OF THE PROVINCIAL DEPARTMENTS.

12. The terms of reference were :—

To consider how far the programmes of the several Provincial and Native States' Departments meet the requirements of the Imperial Bacteriologist and of the other Provinces and States.

The Hon'ble Mr. Hailey then read the report of the Committee which was as follows :—

"The committee note that the recommendations made at the last meeting of the Board regarding the form in which those programmes should be drawn up have been generally observed, and that full details are now given regarding the activities of the Departments.

The only criticism the committee would venture to offer is that on looking to the strength of the superior staff, some of the programmes appear to be unduly ambitious, and that more is being undertaken than can be effectively carried out without an increase of the supervising staff. This applies particularly to the provinces with a single Superintendent.

As regards the last point of the reference, *viz.*, how far the programmes meet the requirements of Imperial Officers and other Provinces and Native States, the extent to which practical effect can be given to much of the work of the Muktesar Laboratory depends on the number of trained men available in the Provinces for carrying out inoculations. The programmes indicate that practically all Provincial Departments are below their proper strength.

They also point to the almost complete absorption of the Superintendents in purely administrative duties. For the furtherance of research work co-operative action between the Muktesar staff and Superintendents, who have opportunities not available to that staff for obtaining material and recording observations on the epizootiology of infective disease, is very desirable, and this can only be ensured by the strengthening of both the Imperial and Provincial staffs."

The report was accepted by the Board.

13. The Committee on Subjects VII and IX consisted of Mr. Chadwick (Chairman), Lieutenant-Colonels Farmer and Smith, Messrs. Edwards, Harris, Meadows, Quinlan, Shilston and Wilson.

SUBJECT VII.—HOW THE ENERGIES OF THE VETERINARY DEPARTMENT CAN BEST BE UTILIZED IN THE CONTROL AND CHECK OF CATTLE DISEASES AND WHAT MEANS SHOULD BE ADOPTED FOR INCREASING THE NUMBERS OF THE SUBORDINATE STAFF AS RECOMMENDED AT THE LAST MEETING OF THE BOARD ?

The terms of reference were :—

To make recommendations.

14. Mr. Chadwick read **the following report** of the Committee which was **accepted by the Board** :—

"For the control and check of cattle diseases it is essential for the staff of the Veterinary Department, both superior and subordinate, to gain the confidence of the villagers and be in the closest possible touch both with them and the local district officers. In most, and perhaps all of the Provinces, the Departments find themselves handicapped in realizing this aim through lack of staff in all grades. It is very desirable that the subordinate staff should be under the control of the Veterinary Department.

Most Provinces have either sanctioned or contemplate schemes for expansion. In the cases in which these are already sanctioned difficulty in obtaining trained men is causing delay in carrying them through. Bihar and Orissa and the United Provinces seem especially to be experiencing this difficulty, which is not likely to be satisfactorily removed until funds permit the construction of the proposed Veterinary College in the United Provinces to serve the needs of that province and of the Hindi-speaking portion of Bihar.

The establishment of this College should also facilitate increasing the numbers of the subordinate staff. It is a matter of great regret to the Committee that Mr. Milne was unable to be present during the consideration of his scheme, as the class of work on which he proposes to employ his short course men is not clear from his report; but generally it is most undesirable to employ any but well trained men in any of the ranks of service wherever such men will be placed in positions of semi-independence.

Although it is perhaps slightly beyond the terms of reference, the Committee would wish to emphasize the need for increasing the strength of the superior staff before a large subordinate staff is recruited in order to ensure adequate supervision, drive and general control. Otherwise, in some Provinces there will be a danger that the superior officers will find their time so fully occupied with administrative work that they will be unable to attend to that instructive work necessary to maintain the efficiency of their subordinates."

SUBJECT IX.—TO WHAT EXTENT FOREST TRACTS ACT AS HARBOURS OF RINDERPEST DURING THE RAINY SEASON AND WHAT STEPS CAN BE TAKEN TO COMBAT THE CONDITION.

The terms of reference were :—

To supply such information as is, at present, known and to make recommendations.

15. Mr. Chadwick read **the following report** on the subject which **was accepted by the Board.**

" In some Provinces serious outbreaks of rinderpest do synchronize with the return of the cattle from the forests and hills to the plains; but the lack of any direct evidence as to the relative importance of this question coupled with—

(i) the impossibility for economic reasons of closing such common grazing in the forests;
(ii) the difficulties in carrying out effective inoculation in such remote tracts;
(iii) the general shortage of staff in the Veterinary Departments,

renders it impossible at this stage to make any recommendations as to the extent to which forest tracts act as harbours of rinderpest during the rainy season and as to what action, if any, could be taken."

16. The Board then proceeded to consider Subjects IV and XII. The Committee on these subjects consisted of Mr. Keatinge (Chairman), Colonels Pease and Evans, Messrs. Clouston, Evans and Ware.

SUBJECT IV.—THE POLICY TO BE ADOPTED IN REGARD TO THE SUPPLY OF CATTLE TO FOREIGN COUNTRIES.

The terms of reference for this subject were :—

To consider whether, in view of the great importance of preserving and improving the existing fine types of Indian cattle, export of animals should be encouraged and if so, whether it would not be necessary to regulate the export where it is of a character likely to affect the best breeds.

17. The President called upon Mr. Keatinge to read the report of the Committee which was as follows :—

" The evidence before the Committee is scanty. Very little information of value can be gathered from the figures relating to this export of animal from the various Indian ports, since these figures do not distinguish between cattle, sheep and goats, but are given for all animals excluding horses, they do not distinguish between animals of good breeds and animals which are of little value except for purposes of slaughter, nor do they indicate clearly the part of India from which the cattle are drawn. It is understood that considerable numbers of inferior cattle are exported from the Madras ports to Ceylon for purposes of slaughter, and from the economic point of view it is desirable that the owners of such cattle in India should not be deprived of the power of realizing a profit by disposing of cattle of this kind which are otherwise of little or no value to them. A fair number of miscellaneous draught and milch cattle are also sent to Ceylon, the Straits and Burma for draught and milch purposes; but there is no reason to object to these. If therefore it were considered necessary to regulate the export of cattle of certain valuable breeds it would be necessary for the Customs Authorities at all ports in India to differentiate between the cattle of these breeds and other classes of cattle, and we think that the difficulty of doing this would be considerable. It would also be necessary to control the export by land of such cattle to foreign territory in India from which they might be exported by sea.

2. As regards the necessity for regulating the export with a view to prevent a serious depletion of the best breeds there are only three such breeds with regard to which we have any evidence that export is proceeding on a large scale.

These breeds are—

(1) The *Kankreji* breed from Northern Gujarat and the adjoining Native States (Bombay).

(2) The Karachi breed (Bombay).

(3) The Ongole breed (Madras).

As regards the *Kankreji* breed, we understand that during the few years prior to the outbreak of war a fair number of such animals, both bulls and cows, have been spasmodically exported, mainly to Brazil. Such animals were good animals, but probably not the very best; and as the breed is fairly extensive, it is unlikely that the export has hitherto materially affected the breed, though it is stated that the experience gained by the men who exported them indicates that a good profit can be obtained by these operations, and that a continuance of the export on a larger scale may be expected when conditions again become favourable to such trade.

As regards the Karachi breed which is a very small and local one, the export during recent years has been relatively very large, and the breed is said to have already suffered seriously from the export of the best bulls and the best cows. The export has been conducted mainly by dairymen who take the best cows to Ceylon for milk purposes, and by the Japanese Government who take the best bulls and cows to Japan for breeding for milk purposes.

In the case of the *Ongole* breed the export has taken place mainly to Java, and it is understood that the Java Government contemplate a continuance and increase of this export. The animals exported are young bulls and female stock, and the export has considerably depleted the breed. This breed is exported to Java for breeding for meat, and while a good class of animal is selected for export, the best have probably remained behind.

3. In the case of those two breeds which have suffered most from export it may be stated that, while the depletion is attributed largely to export abroad, it is recognized that another factor in the depletion consists of the fact that Karachi cows have been purchased largely by the Military and other Dairies and taken to distant parts of India where many of their off-spring get merged in the nondescript local breeds, and that numbers of good Ongole cows are taken to Madras by dairymen and are there slaughtered after their period of lactation is at an end.

4. It appears to be a fact that other tropical countries are beginning to come to India for cattle, something in the same way that countries of temperate climate go to England for the purchase of cattle, and we would hesitate to recommend any measure that would have the effect of depriving the Indian breeder of such profits as may be likely to come to him from this source. It is stated in the case of the Ongole breed that at present the breeder gets little benefit from the high prices paid by foreign purchasers, and that middlemen intercept the enhanced profits. We think, however, that in the long run a large part of the enhanced prices must find their way to the breeders, and that an increased demand for certain breeds of cattle must have the effect of stimulating the breeding of such cattle, to the profit of the breeders.

5. We, therefore, think that the most suitable action on the part of Government to meet the situation would be, not to restrict the export of cattle that are in demand abroad, but to maintain pure herds of such cattle in the middle of the breeding tracts and to assist such breeders in every suitable way to extend and improve their present operations."

Mr. Chadwick said that the report would meet the requirements of Madras excellently.

The report was accepted by the Board.

SUBJECT XII.—THE BEST AGENCY FOR CONTROLLING CATTLE-BREEDING.

18. The terms of reference were :—

To consider and say which of the two Departments—the Agricultural and Veterinary—is, in the opinion of the Board, the better agency for controlling cattle-breeding.

Mr. Keatinge read the following report of the Committee :—

"1. Cattle breeding is a distinct business apart from both agricultural and veterinary work. The qualities necessary for a successful breeder depend far more on a man's personal characteristics, tastes and experience than upon the exact nature of the college instruction that he has received. A man may have received an agricultural or a veterinary training but can become a skilled breeder of any particular class of animal only by long experience in the actual breeding of that class of animal. We consider that cattle breeding is a full time job at which a man must remain all his service, and that in recruiting men to control cattle-breeding the essential matter is to select a man of the necessary character and experience.

2. Looking to the existing cattle-breeding organization in India we consider that it would be very unfortunate if either the Agricultural or the Veterinary Departments were to be entirely disconnected with cattle-breeding or with the wider questions comprised in the term 'animal husbandry.' In connection with animal husbandry the problems appear to differ considerably in different Provinces, and the organization has developed on different lines. Where the problem is merely the improvement of particular breeds the man with most experience of those breeds is the man best suited to control the work. Where the work or projected work is also connected with problems of fodder supply and other economic factors it is essential that the man in control should be well acquainted with the people and with local conditions. Where the work is connected with cattle-keeping as a part of mixed farming it assumes a more definitely agricultural tinge; and this is still more the case in the matter of dairying. In controlling large cattle farms like Hissar the question of contagious disease becomes of primary importance and veterinary knowledge is essential. The organization of the Agricultural and Veterinary Departments varies much in the different Provinces. In some Provinces there is a strong Veterinary staff well acquainted with the Province; while in others this is not so.

3. We therefore consider that it would be best for the various Provinces to arrange for the control of animal husbandry with reference to the particular problems involved and the nature of the agricultural and veterinary organization that may be in existence or contemplated."

The report was accepted by the Board.

SUBJECT VIII.—THE CO-OPERATIVE MOVEMENT IN ITS RELATION TO AGRICULTURE. HOW TO ORGANIZE THE RELATIONS BETWEEN THE CO-OPERATIVE SOCIETIES WHETHER DEALING WITH CREDIT OR SOME OTHER BRANCH OF AGRICULTURAL ORGANIZATION AND THE AGRICULTURAL DEPARTMENTS? WHETHER THERE IS ANY NEED TO ENCOURAGE AGRICULTURAL ASSOCIATIONS IN VIEW OF THE SPECIAL FACILITIES POSSESSED BY CO-OPERATIVE SOCIETIES FOR CARRYING ON PROPAGANDA.

19. This subject was considered by a Committee consisting of Mr. Collins (Chairman), Dr. Mann, Messrs. Blackwood, Clouston, Crosthwaite, Dobbs, Evans, Finlow, Hilson, Roberts, Sitole and Townsend.

The terms of reference were :—

(i) *To make recommendations on the questions raised on the subject.*

(ii) *To consider whether it is desirable that separate capital should be set aside for agricultural improvements which should be distinctive from the banking capital.*

(iii) *To consider how far the suggestions made in the report of the Committee on Co-operation in India, 1915, can be carried into effect.*

Mr. Collins being absent on the day, the President called on Mr. Crosthwaite to read the report on Subject VIII. It embodied the following recommendations :—

"(1) Agricultural Associations perform useful functions where a central co-operative association either does not exist or is not fully developed, and even where such associations do exist there is no need to discourage agricultural associations when the members really undertake pioneer work. But when central co-operative associations are fully developed the Agricultural Department should use them first and foremost as a means for demonstration and the introduction of improvements and should concentrate its attention on them.

(2) Central banks as such should not employ their working capital in commercial enterprises. For the distribution of seed, implements, and other similar activities they should either act as agents or else raise separate capital or make allotments out of profits or reserves. The agency system is working well in the Central Provinces but a form of central association with separate share capital in which societies or individuals would become share-holders might well be developed. All dealings of this kind should be for cash only and members must if necessary borrow from their credit societies for these purposes.

(3) (i) Where credit societies exist in any village, they must be used for getting orders for seed, etc., but as societies they should not engage in trade but only give loans to their members to enable them to make purchases. Agreements to purchase should be taken from individuals before orders in bulk are given.

(ii) Where no credit societies exist co-operative associations such as those described by Mr. Evans in the accompanying Note (see App. C, p. 87) might be found useful. Unregistered co-operative associations for the supply of pure seed, etc., should be discouraged.

(4) The staff of the Agricultural Department, both gazetted officers and others, should receive a practical training in co-operative principles. The Registrar and Director of Agriculture should arrange for such training in agriculture as may be necessary and possible for the staff of central banks.

(5) Over and above the Agricultural Inspectors or Assistants who are to be appointed to each district a Government official subordinate to them and the Deputy Director of Agriculture should be attached to each central bank which is sufficiently developed. Such a man should be a practical cultivator who can read and write.

(6) Government should bear the cost of all demonstration work in each area. Insufficient demonstration and unconvincing results are at the root of much so called apathy on the part of the cultivator. Government must find the money for wide-spread demonstration and for this work alone the staff of the Agricultural Department is at present too small.

(7) Demonstration farms should be started at least at the headquarters of every well developed central bank at the expense of Government.

(8) In the opinion of the Committee cattle insurance is both impracticable and financially unsafe at present and until the arrangements for preventive inoculation are more satisfactory. Better *actuarial data should also be collected. In the meantime central banks should where possible* use their power of refusing loans to aid in the extension of inoculation.

(9) The proposals for the Development Commissioner made by the Committee on Co-operation do not commend themselves to the Committee. Where the Registrar and Director of Agriculture are now directly under Government it would involve extra delay and a loss of efficiency if another officer were put in between. In fact, where these officers are now under a Financial Commissioner or Board of Revenue the Committee strongly recommends that they should be put directly under Government. Co-ordination should be secured by a Board consisting of the Registrar, the Director of Agriculture and, where he exists, the Director of Industries which should meet once a quarter and make their joint representations to Government.

(10) It would be a good thing if some at any rate of the Directors of Agriculture could attend the Imperial Conference of Registrars."

On opening the discussion Mr. Crosthwaite explained that banking liabilities and other liabilities were never allowed to clash and no outside capital is used. A Central Bank may allot a sum for agriculture but cannot show on its balance sheet any money sunk outside pure banking.

Mr. Chadwick then stated a case regarding joint sales of cotton and enquired whether the Central Provinces found any difficulty in this matter. He added that for seed to be kept pure joint ginning was required. 40 to 50 villages in Tinnevelly jointly take their cotton to big gins.

Mr. Crosthwaite gave the instance of a society in the Central Provinces, one of the members of which has a gin, and cotton is ginned co-operatively. There is no share capital but other members pay him.

The Hon'ble Mr. Hailey raised difficulties about the method of obtaining capital for the cotton societies. He thought large capital would be required.

Mr. Clouston then described the Berar Unions, and said that members in three cases out of four have their own gins; in the fourth case arrangements are made with a private gin. Regarding capital, people in Berar levied a 2-4 anna tax per acre grown and raised the money in this way. Some Unions, however, borrowed money from Government as *taccavi* loans. Share capital in Berar was not required.

Mr. Crosthwaite, alluding to the difficulty of audit, said that this was overcome by each member paying rupee one per year for audit, stationery, etc.

The Hon'ble Mr. Hailey said that to keep their cotton pure they have to hire one of West's gins and this is expensive. It seemed to him if Societies were going to develop, more money was wanted to supply gins and asked where it was to come from. Conditions varied greatly in the different Provinces.

Mr. Crosthwaite said Central Provinces were not as advanced as the United Provinces and there would be no difficulty in finding capital for the next five years. On being questioned as to the meaning of the words "agent" and "agency," Mr. Crosthwaite explained the methods adopted in Central Provinces of selling machinery on 2 per cent. commission on sale or return terms. Sales of implements were not restricted to members only.

Mr. Chadwick then pointed out that in Madras under a similar scheme no non-members could purchase the implements.

Mr. Keatinge asked for an explanation of the finance of the farms of the *Agricultural Unions mentioned in Mr. Evan's note.* He questioned the probability of a dividend being paid by a capital of Rs. 500 on a farm of 30 acres and thought it possible that if the farm lost money the members would drop off even though the farm was obtaining valuable results. He was not sure how a small holding conducted by hired labour could pay as a business proposition.

Mr. Evans then fully explained the working of the Union's farm in question. Its capital was Rs. 300 and it made 12 per cent. profit. It was worked by a man and one pair of bullocks except at sowing time when an additional pair of bullocks was engaged. It was managed by a fieldman and a visiting committee of shareholders. They pay rent at Rs. 4 per acre on a five years' agreement and in this case a movement was made by individual cultivators before co-operation came along. The conditions are, however, peculiar. It is merely a question of getting at the people.

Mr. Crosthwaite referring to the above said that we register any society which can be registered under the Act. The terms of reference do not mean that Credit Societies should be the only means of spreading improvements.

20. The President then invited discussion on the 3rd term of reference.

Mr. Crosthwaite said that cattle insurance was impossible until prophylactic measures could be properly undertaken. In Burma rinderpest is not taken under the risk heading and exclusion of this is unsatisfactory. With reference to paragraph 5 regarding the Development Commissioner, Mr. Crosthwaite pointed out that it was essential for the Registrar to be a business-man, to be unfettered by red-tape and secretariat methods and that direct communication with Government was essential and another link in the chain would not help things.

Mr. MacKenna said that in Burma the Director of Agriculture was also a Registrar and he hoped that the Burma scheme for a Development Commissioner would not suffer from any general resolution by the Board.

Mr. Keatinge referred to the methods in use in America where a development commission was of long standing and he thought something in the nature of a development commission would be an advantage.

Mr. Crosthwaite said that it would be a fatal mistake to put a high official of the status of Development Commissioner in charge of the co-operative movement. If he is going to be Chief Registrar and control all finance he will have no time for agriculture or fisheries.

FIFTH DAY.

21. Discussion on Subject VIII was resumed.

The President said that as the Board had discussed the subject in general, he would invite the Board to move resolutions, if any.

Dr. Mann, thereupon, moved **a resolution that :—**

"The Board consider that Agricultural Associations perform useful functions where a Central Co-operative Association either does not exist or is not fully developed and even where such associations do exist there is no need to discourage Agricultural Associations where the members really undertake pioneer work. But where Central Co-operative Associations are fully developed, the Agricultural Department should use them first and foremost as a means for demonstration and the introduction of improvements and should concentrate its attention on them." RESOL

In moving this resolution, Dr. Mann said that in the opinion of the Committee, time has not yet arrived when Agricultural Associations can be entirely dispensed with as aids in bringing agricultural improvements to the notice of the cultivator. He was fully aware that they were not wholly a success in all provinces but in some they had done very useful work.

Mr. Clouston in seconding the resolution said that from his experience of Berar he felt the time had come when we must have larger numbers of Agricultural Associations. He referred to the *tahsil* associations in Berar and as even they were found to be too big the Department was now going in for associations of only 10 villages. Mr. Townsend in support said that in the Punjab they did not wish to drop their agricultural associations as without them they could not get on for years. Mr. Dobbs said that the same thing applied in Bihar. This resolution **was carried.**

22. Mr. Crosthwaite then moved a resolution that :—

"Central Banks as such should not employ their working capital in commercial enterprises. For the distribution of seed, implements and other similar activities they should either act as agents or else raise separate capital or make allotments out of profits or reserves. The agency system is working well in the Central Provinces, but a form of Central Association with separate share capital in which societies or individuals would become share-holders might well be developed. All dealings of this kind should be for cash only and members must, if necessary, borrow from their credit societies for these purposes." RESO

Mr. Collins in seconding pointed out that the object of the resolution was to recommend a policy of sound banking. If Central Banks were to start trading on a large scale they would soon get into difficulty. He emphasized the point that all dealings should be for cash only as, if credit was given, it would be very difficult to carry on dealings on a large scale.

The Hon'ble Mr. Hailey in support said that all operations of agricultural importance in the United Provinces were carried on, on a cash basis.

The Board accepted the Resolution.

23. Mr. Evans then proposed a resolution that :—

"(i) Where credit societies exist in any village, they must be used for getting orders for seed, etc., but as societies they should not engage in trade but only give loans to their members to enable them to make purchases. Agreements to purchase should be taken from individuals before orders in bulk are given.

(ii) Where no credit societies exist co-operative associations such as those described by Mr. Evans in his note (App. C, p. 87) might be found useful. Unregistered co-operative associations for the supply of pure seed, etc., should be discouraged."

While proposing this he dwelt upon the necessity of taking signed agreements from members before purchasing seed in bulk. He referred to his experience in Jubbulpore at Sihora and said that working on this basis they have been able to distribute over 2,000 maunds of selected wheat seed.

Dealing with the second part of the resolution, he said that many co-operative associations are asking to be registered in order to secure credit and the keeping of a proper reserve fund.

Mr. Townsend seconded this resolution and said experience in the Punjab showed the recommendation made by this resolution to be quite sound.

The Board accepted the resolution.

24. Mr. Blackwood proposed that :—

" The staff of the Agricultural Department, both gazetted and others, should receive a practical training in co-operative principles. The Registrar and Director of Agriculture should arrange for such training in agriculture as may be necessary and possible for the staff of Central Banks."

In proposing this resolution he explained that the object of the proposal is to indicate one of the ways by which the Agricultural and the Co-operative Departments can be brought into touch with each other. Some kind of training was, in the opinion of the Committee, necessary on both sides.

Mr. Collins, in seconding the resolution, pointed out that the agricultural staff, if not fully acquainted with co-operative principles, will constantly meet with difficulties and friction may arise. The agricultural staff should, therefore, be properly trained in the principles of co-operation and the co-operative staff should likewise have such training in agriculture as the Director might think fit.

Mr. Leftwich enquired how long the training of agricultural staff in co-operative principles would last.

Mr. Crosthwaite replied that the period must be determined by the Deputy Director of Agriculture but certain essentials of a practical nature should be taught. Mr. Townsend was, however, of opinion that no rule for a definite time was required and it must be left to each Province to determine ; the Board only should lay down the principles.

Mr. Collins advocated the addition of the word " practical " between " such " and " training " in the second sentence of the resolution to which Mr. Blackwood agreed.

Mr. Edwards thought that in smaller provinces like Assam, co-operative societies have not the adequate staff to carry on these arrangements.

Mr. Mackenna proposed the insertion of the word " district " before " staff " in the first sentence of the resolution. The President suggested the insertion of the words " engaged in district work " after the words " Agricultural Department " in the first sentence.

Mr. Chadwick said that in Madras they have arranged for the Registrar of Co-operative Societies to give lectures to students on co-operation and that this should be included in the Agricultural College curriculum, which suggestion was accepted by Mr. Collins.

Mr. Leftwich said that the Economic Botanist and the Agricultural Chemist are frequently employed on duties connected with district work which do not strictly belong to them. In fact they frequently act as executive officers and attend agricultural meetings, and they should not be excluded from undergoing training in co-operative principles.

The Hon'ble Mr. Hailey added that the Assistant Registrar in the United Provinces gives lectures on principles of co-operation at the Agricultural College and the point raised by Mr. Leftwich does not arise in the United Provinces.

Mr. Fletcher wished to move an amendment which would include the whole staff. Mr. Keatinge, however, thought this was unnecessary.

Mr. Dobbs was of opinion that there should be no compulsion introduced into the relations between the Agricultural and Co-operative Departments.

Mr. Blackwood said that the Deputy Directors of Agriculture will arrange for their staff being trained and he would prefer to leave the resolution as it is.

Mr. Fletcher moved an amendment that :—

"District staff of the Agricultural Department, both gazetted officers and others, who are engaged in demonstration work in the districts should receive practical training in co-operative principles."

Mr. Milligan, however, thought that it was not necessary to make it obligatory on all gazetted officers.

Mr. Dobbs pointed out that the wording of the Resolution seemed open to objection as it implies compulsion to learn co-operative principles.

Mr. Mackenna proposed and Mr. Dobbs supported the following alteration in the wording of the Resolution and thought that it would meet all requirements :—

"The Board considers it an advantage that the staff of the Agricultural Departments should be made familiar with the principles of co-operation."

The following amended resolution was thereupon accepted by the Board :—

"The staff of the Agricultural Departments should be made familiar with the principles of co-operation. The Registrar and Director of Agriculture should arrange for such practical training in agriculture as may be necessary and possible for the staff of Central Banks." RESOLUT

25. Mr. Evans then moved a resolution which runs as follows :—

"Over and above the Agricultural Inspectors or Assistants who are to be appointed to each district, a Government official, subordinate to them and the Deputy Director of Agriculture, should be attached to each central bank which is sufficiently developed. Such a man should be a practical cultivator who can read and write." RESOLUT

In moving it he explained that it refers to men of the class of fieldmen who might get at the small cultivator. His duties will chiefly consist of inspecting Unions and arranging a supply of seed.

Mr. Clouston in seconding the resolution said they have already employed an Inspector for the Berar Unions and that they had a man under training who would be paid by the District Boards, but it was thought that he may eventually be paid from profits to be made out of the sale of cotton seed.

The resolution was carried.

26. Mr. Roberts then proposed a resolution as follows :—

"Government should bear all the cost of demonstration work in each area. Insufficient demonstration and unconvincing results are much at the root of so-called apathy on the part of the cultivator. Government must find the money for widespread demonstration and for this work alone the staff of the Agricultural Department is at present too small." RESOLU

In proposing this he said that the Committee felt that in dealing with central banks it was not advisable to ask them to carry out work like demonstration which is outside their sphere altogether.

Mr. Collins, in seconding the resolution, explained that the object of the Committee was to make the principle clear that until a so-called improvement has definitely proved a success in particular local conditions the cost of all demonstration should be paid by Government.

Mr. Dobbs supported the resolution but pointed out that one can never be absolutely certain that an experiment will be a success until it is tried in the locality where it is intended to introduce it.

The resolution was accepted by the Board.

27. Mr. Townsend, in proposing a resolution that "Demonstration farms should be started at least at the head-quarters of every well developed central bank at the expense of Government," remarked that demonstration was the best method of inculcating knowledge into the cultivators and dwelt on the advantages to be derived from the establishment of demonstration farms at head-quarters of central banks.

The resolution was seconded by Mr. Dobbs.

Dr. Coleman stated that he was not prepared to accept the resolution for Mysore as he was against demonstration farms as such and thought that demonstration work could be best done on ryots' own land.

Mr. Townsend thought that it would be a very long time before Government started a demonstration farm at the head-quarters of every central bank.

Mr. Dobbs proposed an amendment to the resolution to the following effect :—

" Where the officers of the Agricultural Departments are in favour of this course, demonstration farms should be started at least at the head-quarters of every central bank at the expense of Government" and the amendment was accepted by Mr. Townsend.

Mr. Chadwick amended **the resolution** as follows :—

" In places in which the Agricultural Department proposes to open demonstration farms in tracts in which there are also well developed central banks, one at least should be started at the head-quarters of such banks at the expense of Government."

This was seconded by Dr. Coleman and **was accepted by the Board.**

28. Mr. Crosthwaite proposed the next resolution which was as follows :—

" That in the opinion of the Board, cattle insurance in India is both impracticable and financially unsafe at present and until the arrangements for preventive inoculation are more satisfactory. Better actuarial data should also be collected. In the meantime, central banks should, where possible, use their power of refusing loans to aid in the extension of inoculation."

He remarked that he had already explained the difficulties which have to be faced regarding cattle insurance and that the object of the Committee was to press upon Government the necessity for more prophylactic measures.

This resolution was seconded by Mr. Roberts.

Major Walker, while agreeing with Mr. Crosthwaite that no disease should be left out of any cattle insurance scheme, thought that the resolution was too sweeping as it would imply that inoculation was the only method of combating disease. He, therefore, proposed the following amendment to the **proposition** :—

" In the opinion of the Board cattle insurance is unsafe unless adequate arrangements are made for dealing with outbreaks of epidemic diseases and that the fixation of tariffs depends on local conditions based on more satisfactory actuarial data than at present exist."

The Hon'ble Mr. Hailey seconded the amendment and it **was carried unanimously by the Board.**

As regards re-insurance, Mr. Crosthwaite stated that it is impossible unless it is spread over large areas and included all risks. Major Walker remarked that re-insurance societies should stand by themselves and that he was against cattle insurance societies being provided for by the credit societies.

Colonel Pease was of opinion that in certain places insurance of cattle would be possible, such as Burma which possibly has special advantages and conditions assisting the inoculation of cattle. Fewer roads and unopened tracts assist the control of contagious diseases, but the conditions in India are different. The country is open and cattle can wander about. Thus it is very difficult for the Veterinary Assistant to get news of the outbreak. The Veterinary Assistant does not reach the scene of outbreak until it has got good hold and done much damage. It seems some misconceptions exist regarding mortality statistics. The mortality from Rinderpest is said to be 96 per cent. in some places, but often in plains and hot districts it is not even 15 per cent. It is, therefore, impossible to state mortality figures, but where mortality is low and the Veterinary staff adequate, insurance is possible. Colonel Pease was of opinion that on the whole cattle insurance was inadvisable in India in the present state of things.

Mr. Crosthwaite remarked that Rinderpest was excluded from cattle insurance in Burma and he thought that any insurance scheme omitting this disease was useless.

Colonel Evans pointed out that Rinderpest was now included in certain number of districts, say 5 central districts in Burma.

29. Mr. Townsend moved the next resolution, as follows :—

" The proposals for the Development Commissioner made by the Committee on Co-operation do not commend themselves to the Board. Where the Registrar and Director of Agriculture are now directly under Government it would involve extra delay and a loss of efficiency if another officer were put in between. In fact, where these officers are now under a Financial Commissioner or Board of Revenue, the Board strongly recommends that they should be put directly under Government. Co-ordination should be secured by a Board consisting of the Registrar, the Director of Agriculture and, where he exists, the Director of Industries, which should meet once a quarter and make their joint representations to Government.'

It was seconded by Mr. Hilson.

Mr. Keatinge said that as the Directors and Registrars of Co-operative Societies are generally in touch with each other and constantly meet to consult, it was not necessary to make it obligatory on them to meet once a quarter and make a joint report to Government. He, therefore, proposed to substitute the words " *from time to time* " in place of " *once a quarter* " and to add the words " when necessary " after the word " Government " in the last sentence of the resolution. This alteration was accepted by Mr. Townsend.

Mr. Keatinge also explained that the term " Development Commissioner " does not imply a pernicious interference. He thought that a wider meaning was to be attached to it. The development in this country has, in his opinion, been very slow. While in other tropical countries, where they have definite developed schemes, the progress has been very rapid. There should be an officer like a Development Commissioner who can frame definite schemes for developing the latent resources of the country. Here, in India, the notion is that the State should assist development. There are high officials of Government, but their time is so much occupied with revenue and other administrative matters that the economic development of the country does not receive sufficient attention and the appointment of Development Commissioner who can push forward schemes to develop the country seems essential. He would, therefore, be sorry if the proposal was dropped solely owing to the imaginary dangers of interference. He, therefore, suggested, and Dr. Mann seconded, the addition of the following sentence at the end of the proposed resolution :—

" This recommendation deals merely with the question of co-ordinating the working of the Departments referred to and is not intended to deprecate the appointment of officers or the establishment of Commissioners which may have for their object the development of the latent resources of the State."

At this stage, Mr. Howard explained that an officer of the status of the Secretary to Government should take up this work of development, which should be endowed and continuous. All savings and surplus of revenues should go to form a development fund.

Mr. Mackenna described the Burma scheme which had been recommended to the Local Government for consideration.

Mr. Crosthwaite, supported by Mr. Collins, moved an amendment modifying **the resolution** as follows :—

" While it desires to emphasize the necessity of adequate programmes of general development and of the regular allotment of funds, the Board considers that in respect of the co-operative movement and of the Agricultural Department the proposals made by the Committee on Co-operation are not suitable. Where the Registrar and Director of Agriculture are now directly under Government it would involve extra delay and a loss of efficiency, if another officer were put in between. In fact, where these officers are now under a Financial Commissioner or Board of Revenue, the Board strongly recommends that they should be directly under Government. Co-ordination should be secured by a Board consisting of the Registrar, the Director of Agriculture and, where he exists, the Director of Industries, which should meet from time to time and make their joint representations to Government when necessary." RES

This amendment was accepted by the Board. Thereupon, Mr. Keatinge withdrew his amendment referred to above.

30. Mr. Collins moved the following resolution which was seconded by Mr. Townsend, and was accepted by the Board :—

" It would be a good thing if some, at any rate, of the Directors of Agriculture could attend the Imperial Conference of Registrars."

SUBJECT XI.—FURTHER CONSIDERATION OF CATTLE-BREEDING AND DAIRYING IN INDIA.

31. The Board then proceeded to consider Subject XI. The Committee on this subject consisted of Mr. Milligan (Chairman), Lieutenant-Colonel Farmer, Dr. Mann, Captain Matson, Major Walker, Messrs. Allan, Branford, Cattell, Coventry, Mackenzie, McKerral, McLean, Quinlan, Smith and Wood.

The following were the terms of reference :—

(i) *To examine the scheme for cattle-breeding and dairying as set forth in the Memorandum by the Agricultural Adviser to the Government of India, dated 19th July 1915, and to make recommendations.*

(ii) *To examine any other schemes, proposals or aspects before the Board and to make recommendations.*

The following report on the subject, copies of which were previously distributed to the members, was taken as read :—

The Committee discussed the scheme in detail and have the following recommendations to make :—

(i) *The appointment of an Imperial Expert Breeding and Dairying Officer with the title of "The Imperial Dairy Expert" whose principal duties would be :—*

(a) the control of the cattle-breeding farms and dairy operations contemplated in the scheme ;

(b) the supervision of dairy instruction ;

(c) the study and improvement of existing dairy methods in the country and the establishment of the industry on a commercial basis ;

(d) generally to advise and assist Local Governments, Provincial Officers, Military Dairy Farms, Municipalities and private institutions on cattle-breeding and dairying including organization, improved methods, the erection of dairies, building plant, marketing, training, etc.

The Committee consider that the appointment should be a permanent one in the sense that the holder should not be liable to transfer.

Cattle-Breeding and Dairying Instruction.

The Committee consider that the offer of help from the Military Dairies is of the highest value as offering a substantial foundation for future development. Mr. Coventry's recommendations are accepted with some slight amendments. The amended scheme now reads as follows :—

A.—*Cattle-Breeding.*

(a) The Imperial Expert to have for breeding purposes the use and control of the following herds of pure indigenous strains and with the concurrence of the Director, Military Dairies, powers of redistribution, and of adding to the herds for the production of indigenous pedigree stock of good milking strains :—

Lahore-Ferozepore.—200 pure bred Saniwals giving approximately 60 young bulls a year after three years for distribution in the Punjab.

Lucknow.—150 pure Hariana giving 50 young bulls a year for distribution in the United Provinces.

Poona.—120 pure Sindhis giving 40 young bulls per annum for distribution in the Deccan.

Belgaum.—100 pure Sindhis giving 30 young bulls for distribution in South Deccan.

Umballa.—120 pure Saniwals giving 40 young bulls for distribution in the Punjab and United Provinces.

Jubbulpore.—100 Hariana cows giving 30 young bulls for distribution in the Central Provinces.

Quetta-Ruk.—120 pure Sindhis giving 40 young bulls for distribution.

No mention is made in the scheme for provision of bulls for Burma, Bengal, Assam, Madras and Bihar, but it is understood that Military Dairy Farms may shortly be started one near Calcutta and one in Hyderabad (Deccan) from which bulls might be distributed to Bengal and Madras.

(b) Cross-breeding.—The Imperial Expert might have at his disposal the two following farms for the purpose of cross-breeding ; *viz.*, Umballa and Bangalore. At each of these stations breeding experiments would be carried out in crossing with imported blood with the primary object of increasing the yield of milk. Incidentally an endeavour might be made in the experiment to fix a type of animal suitable for both milk and draught purposes. In this work the Veterinary staff at Muktesar would co-operate in rendering cross-bred cattle immune or resistant to disease. It may be found possible to extend this cross-breeding work to other farms, care being taken that no cross-bred bulls be issued.

(*c*) Breeding of buffaloes.—Young selected buffalo bulls of good strain 3½ years old to the number of 200 per annum might be supplied from various Military Dairy Farms for distribution.

There would be thus to commence with seven herds of pure indigenous strains aggregating 900 head from which an approximate annual return of 300 bulls 3½ years old is estimated for distribution to Provinces. There would also be an estimated return of 200 bull buffaloes for the same purpose. The Military Dairy Farm might be asked to place at the disposal of the Imperial Dairy Expert a certain number of buffalo herds for experimental purposes.

It is further suggested that these bulls and buffaloes should be handed over to Local Governments for distribution. The price to be paid by the Imperial Agricultural Department to Military Department would be the actual cost reckoning food, housing, labour and actual incidental expenses, but not including administration or management charges, interest on capital, etc.

B.—*Dairy Instruction.*

The question of systematic dairy education with a view to train well qualified dairy managers should be dealt with in an experimental manner at present, though it is practically certain that in a very few years more complete arrangements will have to be provided, in the light of the experience gained.

Two methods of establishing dairy schools have been recommended, and a school of each pattern, in the opinion of the Committee, should be opened. The first should be established at Poona under the conrtol of the Agricultural College authorities, and should make use of the College staff for the scientific and cognate instruction. The practical training would be given at the Military Dairy Farm, Kirkee, where the students would reside. For this school it would be necessary to provide a hostel at the Military Dairy Farm, while the additional staff would simply consist of a Farm Manager, resident at the Military Dairy, who would be in charge of the practical dairy training of the students and a lecturer.

The second dairy school should be established at Lucknow under arrangements similar to those proposed in Mr. Coventry's Memorandum. It would be independent of any Agricultural College, and, under the supervision of the Imperial Dairy Expert, would be under the control of the Military Dairy Farm authorities at that place. It would be in charge of a special Farm Manager assisted by a lecturer. A hostel, lecture room and laboratory would be provided. After some time the success or otherwise of the two types of school could be compared and further progress made on the lines which then seem wisest.

The Committee consider that there is sufficient demand for all the men that these two schools would be likely to supply, provided the entries at each are limited to 15 per annum.

The course should be of two years, complete in itself and presupposes simply a good general education. It need not be done entirely in these schools or in one place but may be carried out in part or altogether at other places recognized for the purpose such as Agricultural Colleges, properly equipped, provided a minimum of two years including vacations is given to the subject and certain minima of time are devoted to the several parts of the subject. For students who have passed through such course an examination would be held at the end of the course and a diploma awarded on the result. The general arrangements for this would be made by the Imperial Dairy Expert with such other authorities as may be associated with him.

C.—*The Determination of Food Values and the Digestive Capacity of Indian Farm Animals.*

The employment of a chemist is recommended for :—

(*a*) the estimation of the value of Indian feeding stuffs by analysis ;

(*b*) the estimation of the digestibility of feeding stuffs ;

(*c*) the relative digestive capacity of cattle and buffaloes ;

(*d*) practical feeding experiments ;

(*e*) the determination of the individual values *ab initio* ; (*a*), (*b*) and (*c*) may be taken up at once at Pusa or at any other suitable place where the Chemist would be posted and where he would be provided with cattle and buffaloes ; (*d*) could be carried out at the Military Dairy Farm and at Pusa, while (*e*) might be deferred for the present.

D.—*The Immunization of Cattle against Disease.*

Owing to the great importance of the proposed breeding operations, the value of the stock involved and the enormous losses which might follow from an outbreak of disease, immunization of the cattle by inoculation is imperative. It will be necessary to call upon Muktesar to undertake this. It is important that the inoculations should be supervised by an officer belonging to the superior staff the whole of whose time would be devoted to this particular work. This in effect means the necessity of appointing another officer to the Muktesar staff. An estimate of the cost of this proposal is shown below under (F) *Budget*.

E.—*Legislation.*

The Committee are agreed that the need for protective legislation in respect to the purity of dairy produce offered for sale as recommended by the Board of Agriculture at the 1913 meeting (paragraph 43, page 49 of the Board's Proceedings) is essential, especially in the larger cities.

(ii) To examine any other schemes, proposals or aspects before the Board and make recommendations.

The Committee consider that the adoption of the above scheme will mark a distinct advance towards organized effort to improve cattle-breeding and dairying in India but realize that the great bulk of the work will of necessity lie with the Provinces. As cattle-breeding and the dairy industry are essentially connected from an economic point of view, the Committee recommend that before any fixed policy is adopted by the Provinces an investigation into the existing supply and demand for dairy produce should be instituted by Provincial Governments. The Report of the Committee appointed to consider measures for the improvement of the milk supply in large cities in the Bombay Presidency might serve as a useful reference as to the class of information on which schemes could be framed. Until such information is forthcoming the Committee do not consider that they can offer in this connection any advice which would be of any real value.

With regard to the general question of measures for

(*a*) the protection and amelioration of the existing indigenous cattle-breeding industry, the preservation and multiplication of the existing fine types of Indian cattle, and the organisation and regulation of breeding tracts,

(*b*) the preservation of grazing areas, the improvement of waste areas, and the general question of fodder supply,

the Committee feels that Local Governments have already acquired a mass of information on the subject and are in most cases taking such action as lies within the means at their disposal. Many Departments, however, have been and are still severely handicapped by the want of sufficient superior staff. It should not be forgotten however that a large proportion of the Indian plough cattle are bred within the boundaries of the Native States and the Committee consider that the importance of improving the stock and developing the industry should be brought to their notice. With regard to general measures which can be recommended to Local Governments and Native States the Committee endorse the findings of the Committee which sat on the subject at Coimbatore in 1913. (Page 16 of the Proceedings of the Board of Agriculture, 1913.)

The Committee desire to lay special stress on points 3 and 9 which refer to the necessity of the establishment of a larger number of cattle breeding stations and the provision of more men for the work.

F.—*Budget.*

An attempt has been made to give below an approximate cost (capital and recurring) of the scheme suggested in this Report. It is estimated that the cost would be roughly as follows :—

CAPITAL.

	Rs.
1 Dairy School each with lecture room and laboratory for 40 students at Rs. 9,000	9,000
2 Residences attached to the Dairy School for Farm Managers attached to Dairy Schools at Rs. 10,000	20,000
3 Residences attached to Farms for breeding operations at Rs. 10,000	30,000
2 Hostels attached to Dairy Schools with quarters for lecturers at Rs. 22,000	44,000
Furniture for Dairy Schools	5,000
Purchase of buffaloes at Pusa for the Chemist	5,000
Residence of Chemist	20,000
Residence of Assistant Bacteriologist at Muktesar	22,000
Laboratory and furniture for Chemist	12,000
Cattle sheds and weigh bridge for Chemist	3,000
TOTAL	1,70,000

RECURRING EXPENDITURE.

Imperial Breeding and Dairy Expert.

Pay of officer Rs. 1,500	18,000
Clerical establishment (5)—	5,220
1 (100—10—150), average 137½.	
2 (75— 5—100), average 187½.	
2 (40— 4—60), average 110.	
Menials (4), 1 (10), 3 (8), average 34	408
Travelling allowance	3,000
Contingencies	1,500
TOTAL	28,128

Dairy Schools.

2 Farm Managers on a time-scale of pay of Rs. 200 rising to Rs. 700 (average 405 *plus* charge allowance Rs. 50)	10,920
2 Lecturers (250—30—400) average Rs. 350 *plus* Hostel allowance Rs. 50	9,600
Allowance to Farm staff at 2 Farms	2,400
Servants, 4 (8)	384
Contingencies	1,000
TOTAL	24,304

Breeding.

Additional cost thrown on the following Military Farms on account of breeding operations :—

Lahore-Ferozepore	10,500
Lucknow	11,250
Poona	9,000
Belgaum	7,500
Amballa	9,000
Jubbulpore	7,500
Quetta-Ruk	10,000
Bangalore (cross-breeding)	2,500
Amballa (cross-breeding)	2,500
Approximate cost of rearing 500 bulls at Rs. 200. (This amount will be recovered by sale of bulls)	1,00,000
Extra supervision of 3 Farm Managers for breeding operations on a time-scale of Rs. 200 rising to 700 or average Rs. 405 *plus* Rs. 50 allowance	16,380
TOTAL	1,86,130

Chemist.

	Rs.
Salary (900 *plus* 100 local allowance)	12,000
2 Assistants (150—10—200) average 366⅔	4,400
4 servants, 1 (10), 3 (8), average 34	408
Travelling allowance	1,000
Contingencies	1,000
Supplies and Services	2,000
Feed and Keep of cattle	1,000
TOTAL	21,808

2nd Assistant Bacteriologist, Muktesar.

Salary (average Rs. 995 per mensem)	11,940
2 Veterinary Inspectors (Rs. 100—150)	3,000
4 Dressers at Rs. 12	576
2 Peons at Rs. 10	240
Travelling allowance	3,000
Contingencies	500
TOTAL	19,256

Abstract of Recurring Expenditure.

Imperial Officer	28,128
Dairy Schools	24,304
Breeding	1,86,130
Chemist	21,808
Assistant Bacteriologist at Muktesar	19,256
TOTAL	2,79,626

32. Mr. Milligan then moved a resolution :—

" That the Board is of opinion that in order to make satisfactory progress in the development of good breeds of milk cattle in India and in dairying, an Imperial Expert Breeding and Dairying Officer should be appointed with the title of Imperial Dairy Expert whose practical duties would be :—

(*a*) the control of the cattle-breeding farms and dairy operations contemplated in the scheme ;

(*b*) the supervision of dairy instruction ;

(*c*) the study and improvement of existing dairy methods in the country and the establishment of the industry on a commercial basis ;

(*d*) generally to advise and assist Local Governments, Provincial officers, Military Dairy Farms.

They consider that the arrangements proposed and the estimate prepared by the Committee are reasonable and that the holder, once appointed, should not be liable to transfer."

In proposing this, Mr. Milligan remarked that it was evident that at present very little can be done under existing organization as we have no farms and no money. This scheme makes considerable provisions for carrying out the suggestions of the last Board and those of Mr. Coventry which were approved of by the Military Dairy authorities. Referring to the appointment of the Expert, Mr. Milligan said that he thought it was evident to the Board that such an officer is essential. There are three big problems to tackle-(1) cattle-breeding, (2) giving of dairy courses and (3) organization of dairy industry. A man who will take up the duties and who will supervise (1) and (2) is wanted . With due selection such a man will be forthcoming. He thought that the Board would agree that such an expert would be worth the money. Mr. Quinlan seconded the resolution.

Mr. Townsend enquired whether the expert would have to deal with plough cattle.

Colonel Pease suggested that the resolution might be altered slightly to meet the question raised by Mr. Townsend.

Mr. Chadwick also raised the question regarding the control of the proposed expert over provincial cattle-breeding farms. Mr. Milligan pointed out that his control will only extend to the farms offered by the Military Dairy Department. At the last Meeting of the Board held at Coimbatore, it was thought not incompatible to join milk and draught qualities (a dual purpose animal). Colonel Pease

did not think it possible to get any of the very fine breeds of draught cattle in India to become also milch breeds without deterioration in draught cattle. He said this as the result of 31 years' experience. The proposed officer should not be an expert in breeding draught stock and he thought the scheme should be limited to milch cattle. Dr. Mann explained that the resolution referred to milch cattle and pointed out that breeding cattle for draught is for Provinces and not for the Imperial Expert. Colonel Pease then suggested the words "Expert Breeding and" should be omitted because it is impossible for a man to be expert in all breeds of cattle in India, let alone other animals. Mr. Milligan agreed to this.

The President said the resolution should read as under :—

> "An officer should be appointed to the Imperial staff with the title of Imperial Dairy Expert."

Mr. Meggitt thought this officer would have far too much work since he would be liable to be called on for advice by Municipalities all over India. Mr. Chadwick pointed out that this advice stopped at Local Governments and does not extend to Municipalities and that he would have staff under him.

After this discussion, **the Board accepted the** amended **resolution as follows :—**

II. **"That the Board is of opinion that in order to make satisfactory progress in the development of good breeds of milk cattle in India and in dairying, an officer should be appointed to the Imperial staff with the title of Imperial Dairy Expert, whose practical duties would be—**

- (*a*) **the control of the cattle-breeding farms and dairy operations contemplated in the scheme ;**
- (*b*) **the supervision of dairy instruction ;**
- (*c*) **the study and improvement of existing dairy methods in the country and the establishment of the industry on a commercial basis ;**
- (*d*) **generally to advise and assist Local Governments, Provincial officers and Military Dairy Farms.**

They consider that the arrangements proposed and the estimate prepared by the Committee are reasonable and that the holder, once appointed, should not be liable to transfer."

33. Major Walker then moved a **resolution** which runs as follows :—

IV. **"That the Board is of opinion that the offer by the Military authorities of the herds of various breeds of pure bred Indian cows and buffaloes, as well as of the facilities for conducting further breeding work on the Military Dairy Farms is of extreme value, and should be gladly accepted. They recommend that advantage should be taken of it as soon as the Imperial Dairy Expert referred to in the foregoing resolution is appointed."**

He said that the demand for good bulls seems to be satisfactory but their number is not large. If more good bulls are provided and Local Governments use their influence to get people to take these bulls much advance will be made. The scheme is, to a large extent, experimental but it commended itself to Major Walker as it contemplates experiments in cross-breeding which will be most interesting and he hoped the demand would come. The expert would have powers of adding to the herds under his control and also power of redistribution.

Since the Board recognize the necessity for breeding good cattle and bulls the help promised by Military Dairy Farms is well worth it. Lieutenant-Colonel Farmer seconded the resolution.

Mr. Townsend suggested that it might be made clearer whether the Imperial Department of Agriculture would take over the bulls from the Military Dairies. Mr. Milligan said they would do so in the first case and pay for them.

Colonel Hallowes gave his experience of the Military Dairy Farms. He said that when started they had no dairy expert with experience of Indian conditions or necessary methods and now that this scheme would have the benefit of all the experience he felt it would be worth having. Colonel Pease said he was entirely in sympathy with the whole scheme and wished it would go through. He

then enquired on what basis the number of progeny of Saniwals were given in the statement. Captain Matson replied that they were actually based on experience. Mr. Keatinge wished to know if the Military Dairy authorities would vary the nature of their herds in order to meet the local requirements. He doubted if the Karachi cow would be liked by the Deccan dairymen and there may he no demand for them. The Surti breed of buffaloes might be tried. He also doubted whether Karachi bulls would do with the non-descript village cows in the Deccan. Mr. Smith replied that the scheme is put up only for a start. The Military herds were there only because they give most milk. If it is possible an indigenous breed will be obtained. The Surti breed will not stand Poona climate but the Delhi buffalo does well there.

Mr. Leftwich referred to the Hariana cows giving 30 bulls for distribution in the Central Provinces and raised a note of warning as to their suitability.

Colonel Pease understood that the Military Farms did not pay and he thought it a bad thing to take a non-paying thing into a district. Mr. Milligan pointed out that experiment will first be made before demonstrating. Mr. Smith replied that the Military Farms are not run on commercial lines; but in accordance with what soldiers can afford to pay. Mr. Clouston enquired from Mr. Smith whether he believed in crossing breeds for milk purposes. Mr. Smith said that in his belief the Hariana breed would benefit the Jubbulpore district by crossing. Major Walker's resolution was then **accepted by the Board.**

34. In moving **the** next **resolution**—

"That the Board approves of the scheme of dairy instruction outlined under section B in the Committee's report, and consider that, if carried out, it will fill the need for trained dairy managers for some years to come." Re-

Dr. Mann said that lack of satisfactory dairy managers was the rock on which all enterprise in dairy lines foundered. Ordinary agricultural college courses do not give sufficient dairy training; the Military Dairy Farms were the only places where training could be given. But they are business concerns and could not give it except to their own men. The Committee's proposals are meant to remedy this. 25 dairy managers are wanted, 6 per year for Bombay Presidency alone. Thus if we provide 16 to 25 per year there will be a demand for them. Two dairy schools are proposed, one at Poona and the other at Lucknow of slightly different types. It is recognized that dairy managers must be trained at a large dairy and this is found at Poona under Agricultural College authorities. The second school would be at Lucknow attached to the Military Dairy Farm there just as in Mr. Coventry's scheme. He said that the scheme does not exclude other Agricultural Colleges doing their part of training. Before such students appear for any diploma, however, they would have to put in a minimum of time at a big dairy. This is essential. The resolution was seconded by Mr. Wood and **accepted by the Board.**

35. Lieutenant-Colonel Farmer then proposed a resolution—

> "That the Board is of opinion that the problems of the feeding of live-stock, and particularly of dairy stock, in India are such as to require the appointment of a Chemist at least for a period of ten years to carry out investigations into the problems indicated under section C in the Committee's report. The Board consider the scheme therein outlined is satisfactory and the expenditure reasonable."

In moving it he said that the Committee wish that investigations be made on food stuffs and their feeding values. He feared the staff suggested was not large enough but he felt the Chemist, when appointed, could advise still further as to the increase of staff.

Mr. Smith in seconding the resolution said that there are no data at present as to how to make up rations scientifically. They are now done by rule of thumb. Nothing is known of value of digestibilities of mixed cakes, etc. It was the duty of Government to provide accurate and clear information on the subject.

Mr. Dobbs said that he would like to draw attention to the resolution passed by the Board at Coimbatore on this subject. He thought the Board ought to avoid contradicting that. Mr. Barnes observed that in his opinion that only

affected the then existing staff of the Agricultural Department. Colonel Pease remarked that in his opinion the resolution in question was only made for that year. Lieutenant-Colonel Farmer then said that because the Board had expressed an opinion it does not follow that subsequently it cannot give another opinion.

Lieutenant-Colonel Farmer then amended his resolution as follows :—

VI. **"That the Board is of opinion that the problems of the feeding of live-stock, and particularly of dairy stock, in India are such as to require the appointment of a Chemist at least for a period of ten years to carry out investigations into the problems indicated under Section C in the Committee's report. The Board have reconsidered the resolution of the last Board of Agriculture at Coimbatore, and in view of the requirements of dairying and the increased opportunities of carrying out experimental work the new proposal is satisfactory and the expenditure reasonable."**

Mr. Smith seconded the resolution as reworded. Mr. Wood said that there are now far increased opportunities for experimental work as there are Military Dairy Farms.

The resolution as amended **was accepted by the Board.**

36. Mr. Smith then moved a resolution that :—

VII. **"The Board is of opinion that the whole future of the proposed scheme for the improvement of dairying in India is largely affected by the possibility or otherwise of satisfactory arrangement being made for immunising the cattle against disease. They, therefore, consider that the increase in the Muktesar staff proposed by the Committee for this purpose is reasonable and is essential to the success of the scheme as a whole."**

He referred to large losses by epidemic diseases among these cattle and to the extraordinary benefit which has been derived from prophylactic measures. He also added that in speaking of a herd we must not take actual but potential value. Hence the necessity of immunisation.

Mr. Roberts seconded **the resolution** which **was accepted by the Board.**

37. Mr. Wood then moved the following resolution :—

VIII. **"That the Board consider that before any fixed policy is adopted in the various Indian Provinces for the encouragement of the dairy industry an investigation into the existing supply and demand for dairy produce should be instituted by Provincial Governments. Only when such information is available will it be possible to indicate the lines of action which promise the most complete success."**

He explained that the Committee were impressed by the value of the report by the Bombay Agricultural Department on the improvement of the milk supply in large cities in that Presidency and the Committee wish to recommend that some such enquiry be made by all Local Governments before attempting to improve dairying.

Mr. Mackenzie seconded **the resolution** which **was accepted.**

38. Dr. Mann then proposed a resolution :—

"That the Board re-affirms its conviction that legislation to protect honest traders in dairy produce against unscrupulous adulteration is essential."

He thought that every one feels that any honest work on dairy question is neutralized by the adulteration of milk and the impurity of the supply to the public ; legislation is required before any honest man can go into the trade. This can be done in two ways : (1) American pattern of producing certificated milk, *i.e.*, traders can submit their products for examination and get on a register and (2) legislation against adulteration. The difficulty is that an immediate rise in price would follow and hit the people who suffer most from adulteration. He, however, felt sure that it would not be of long duration, but in any case legislation is required to allow the dairy industry to develop. Mr. McLean seconded the resolution.

Mr. Barnes believed that legislation is already in existence but the difficulty is to secure Inspectors to do this work. Dr. Mann admitted the difficulty but did not think it insuperable. Mr. Plymen asked whether there were general or local Municipal bye-laws in this matter. Dr. Mann said the Municipal Act refers to all Municipalities in the Bombay Presidency. Mr. Barnes pointed out to the Board that they were dealing with a very difficult matter and he wished the resolution to be put in such a shape as to call Government's attention and also that of the district officers. The difficulty is to get Indian Inspectors to do this duty.

Mr. Barnes proposed **the** following **amendment**:—

"That the Board re-affirms its conviction that legislation to protect honest traders in dairy produce against unscrupulous adulteration is essential and in view of the administrative difficulties of rendering such legislation effective recommends the formation of a Committee of enquiry in each Province on which district officers should be represented." RES

Mr. Roberts seconded this amendment which **was carried,** 13 being in favour and 4 against.

39. In putting forward **the next resolution that—**

"The Board re-affirm the resolution passed at Coimbatore in 1913 with regard *to the conditions for the improvement of cattle in India as found on page 16 of the* Proceedings and desire to lay special stress on points 3 and 9 in the report of the Committee then adopted." RES

Lieutenant-Colonel Farmer said that far more can be done for cattle-breeding than has been done up to date. He thought degeneration was going on already and without suitable officers to supervise breeding work they would soon be in a bad way.

Mr. Smith, in seconding, said that he would suggest more stock breeding farms and better men to run them. The improvement brought about on the cattle farm at Hissar is most noticeable.

The resolution **was** then **carried.**

SUBJECT V.—THE NOMENCLATURE OF CERTAIN POSTS IN THE IMPERIAL AND PROVINCIAL DEPARTMENTS OF AGRICULTURE.

40. The Committee for this subject consisted of Mr. Mackenna (Chairman), Messrs. Blackwood, Edwards, Hailey, Keatinge, Leftwich and Townsend.

The terms of reference were:—

To examine the nomenclature of the posts in the Departments of Agriculture and to say whether it is uniform and correctly indicates the work in which officers are employed; whether it indicates relation between the Imperial and Provincial Services, and, if no leave reserve is provided in the Imperial Service, whether the Board can recommend a nomenclature which expresses the intention to give in cases of leave vacancies opportunities to members of the Provincial Service to prove their fitness for permanent promotion.

In the absence of Mr. Mackenna, Mr. Keatinge read the report of the Committee.

Dr. Butler pointed out that the words "Imperial and Provincial Departments of Agriculture" in the first sentence of paragraph (iii) of the report were misleading. The President said that the word 'Departments of Agriculture' was a mistake for "Agricultural Services" which should be substituted.

The amended report which was accepted by the Board is given below:—

(i) The Committee recommend that Deputy Directors of Agriculture be designated by Circles, rather than by serial numbers indicative of seniority in the service.

(ii) The Committee were advised by the Hon'ble Mr. Hailey that confusion has arisen in the United Provinces owing to the designation "Assistant Director" having been given to officers of different services performing totally different duties. The Committee recommend that this designation be reserved for junior officers of the Indian Agricultural Service until they are confirmed in charge of Circles.

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(iii) The Committee consider that no distinction should be made between the Imperial and Provincial Agricultural services in the designation of officers performing the same duties. No distinction is made in the case of district officers in other services: Deputy Commissioners, Civil Surgeons, Superintendents of Police and others are designated as such whether the individual officers are of the Imperial or Provincial Services. The Committee recommend that, in the same way, an officer of the Provincial Service be designated as Deputy Director when appointed to the permanent charge of a Circle: the word "Acting" would be prefixed when the appointment is not permanent. The same rule should be adopted in the case of experts like the Economic Botanist and Agricultural Chemist.

(iv) In order to make the status of experts more clear, the Committee recommend that the words "to Government," and the name of the Presidency or Province be added to their designation: thus "Economic Botanist to Government," Agricultural Chemist, Entomologist, Mycologist, Agricultural Engineer, etc., "to Government."

(v) The Committee having considered the various designations of Executive Officers of the Provincial Services, recommend that the title "Divisional Superintendent of Agriculture" be uniformly adopted in all Provinces.

(vi) As regards the Subordinate Services, the Committee observe that the practice and scales of pay in different Provinces are so widely divergent that they do not consider it would be desirable to interfere with a view to attaining uniformity which does not seem necessary.

(vii) With reference to the latter portion of the terms of reference, the Committee have no recommendations to make to that end. They believe that their recommendations in paragraphs (i) to (v) will dissipate all confusion.

SIXTH DAY.

SUBJECT VI.—SOIL DENUDATION, AND SURFACE DRAINAGE: THE CONSERVATION OF SOIL MOISTURE.

41. The Committee on this subject consisted of Mr. Howard (Chairman), Dr. Hope, Mrs. Howard, Messrs. Anstead, Bainbrigge Fletcher, Clarke, Hilson, Hutchinson, Keatinge, and Mackenzie. The terms of reference were:—

To make recommendations.

Mr. Howard read the report of the Committee on "Soil denudation by rainfall, and drainage: conservation of soil moisture" printed below (page 38).

Upon the President's inviting discussion on the report, Mr. Robertson Brown stated that one aspect of the conservation of moisture occurred to him. While the ryot in North-West Frontier Province got one irrigation for R. 1, he was not likely to do one intercultivation recommended as it costs Rs. 3-8 per acre. He also pointed out that when the crop was high it was not possible to do interculture more than twice. Mr. Howard explained that Mr. Robertson Brown had not looked at the matter from the point of view of the welfare of the plant. If we use excess of moisture we do irreparable mischief. Mr. Robertson Brown contended that it was the question of money first and of the welfare of the plant afterwards. Cultivators were not open to conversion on such lines. They know that more water means less labour and act accordingly. To this Mr. Howard replied that when shown that less water means higher returns, the cultivator will be converted. Mr. Milligan expressed his views in favour of interculture and pointed out that a harrow is an efficient implement for the purpose. It is cheap both to use and make. One can make it for Rs. 5 or 6. But harrowing cannot be done if it is deferred until the crop is high. Mr. Robertson Brown pointed out that a lever-harrow simply scores the land and that harrowing is not possible in the cane crop as it is grown on ridge and furrow system. Mr. Roberts held that the interculture was very cheap. In North-West Frontier Province more water is possibly available than the land requires and hence it is there cheaper to irrigate than to intercultivate.

42. Dr. Hope then proposed a resolution that

"The Board suggests that the Government of India be asked to bring to the notice of planters through the medium of the Indian Tea Association, the United Planters' Association of South India, district officers and other convenient channels the fact that the serious losses due to soil erosion in the planting districts, which have taken place in the past, are, to a large extent, preventable; that the most effective measures should be taken now on existing areas and when new areas are opened. Failing this, it may be necessary for Government to reconsider the conditions on which new lands are given out."

In moving this resolution he said that the interests of the planting industry of North-East and South India are watched by representative Associations which advise their respective planting communities of the occurrence of important matters affecting the industry, and to some extent control its policy and act as its mouthpiece. Although very serious mistakes and omissions have been made in the past in estate management these mistakes are now realized by planters and steps are being taken by them to remedy matters and he was, therefore, of opinion that if the resolution before the Board be passed and be represented to these Associations they would be able and willing to impress on the planting community, with sufficient emphasis to ensure the necessary action being taken, the importance of preventing as far as possible further damage to estates by soil erosion.

Mr. Anstead in seconding the resolution said that in planting districts of Southern India losses of soil have undoubtedly taken place in the past which were preventable; the problem of soil denudation is largely one of economics and every planter is faced with it. Every year more attention is paid to the matter and better methods are adopted for its control though there is still much which might be done.

Personally he was opposed to any kind of legislation which might hamper in the least the developing of any agricultural project in this country and in this case he thought legislation was quite unnecessary.

If, however, the Board were to pass this resolution with its threat of legislation, it may help to strengthen the hands of those officers who are engaged in teaching the necessity and the best means of prevention of soil erosion.

Mr. Milligan thought that the resolution would be just as effective if the last sentence was omitted as it was somewhat of a threatening nature. The words "failing this" in the last sentence indicate threat.

Mr. Keatinge, however, maintained that the state of things called for immediate action and though he did not know the conditions of the planting areas yet he felt the deletion would take all the sting out of the resolution. Much damage is going on and it will be impossible to repair it.

Mr. Howard explained that the Government of Java will not give out any land unless the planters agree to take measures to prevent erosion. The Government there feel that as the area of land is small they must do their utmost to preserve the cultivable area. He also referred to his visit to Ceylon and his conversations with planters on this subject. He thought that if Government had, in the past, compelled terracing by legislation things would never have reached this stage. He, therefore, wished the sentence to remain in tact so as to strengthen the hands of the expert advisers.

Dr. Coleman agreed with Mr. Howard and said that such a resolution would strengthen his control when new areas were being taken up in Mysore.

Mr. Chadwick observed that the Board could not bind Government down to do any thing in particular as it meets only in an advisory capacity. He pointed out that by altering the words of the resolution the difficulties can be smoothed over and suggested the following emendation:—

"The Board would suggest that the Local Governments should endeavour to safeguard against this danger of erosion when fixing the conditions on which new lands are given out."

Dr. Mann then suggested the following alteration in the wording of the last sentence:—

"It would suggest that in giving out new lands the conditions should be such as to prevent, as far as possible, the soil denudation which has been so disastrous in the past in the planting districts."

Mr. Howard thereupon pointed out that Dr. Mann's emendation was stronger than Mr. Chadwick's.

Dr. Coleman was in favour of omitting the words "failing this" in the original resolution, and Mr. Chadwick again pointed out that we can only make suggestions to Government.

Dr. Hope having agreed to Mr. Chadwick's emendation, the **following** amended **resolution was accepted by the Board :—**

I. **"The Board suggests that the Government of India be asked to bring to the notice of planters through the medium of the Indian Tea Association, the United Planters' Association of Southern India, District officers and other convenient channels the fact that the serious losses due to soil erosion in the planting districts which have taken place in the past are, to a large extent, preventable ; that the most effective measures should be taken now on existing areas and when new areas are opened. The Board would suggest that the Local Governments should endeavour to safeguard against this danger of erosion when fixing the conditions on which new lands are given out."**

43. Dr. Mann then proposed a **resolution** that

II. **"The Board recommends that the Government of India be requested to place at the disposal of the Agricultural Department of Bombay an Engineer with experience and aptitude for agricultural work whose sole duties will consist in the preparation and execution of schemes of embankments and drainage adapted to local conditions."**

In moving this resolution he said that every one who has travelled in the Bombay Presidency knows that ryots want either to dig wells or embank their fields. He thought that the appointment of an Engineer to advise the ryots in Bombay Presidency in connection with embanking would produce a more marked improvement in the value of the produce than any other way. There was a great field open for this work in Bombay, and it is of great necessity to show the ryots how best to plan and perform this work which they already regard as a necessity. He believed it would be an object lesson and would also benefit many other parts of Peninsular India.

In seconding the resolution, Mr. Howard added that in such a scheme the man selected is everything. Bombay should search India and the Empire, if necessary, to get the right man.

On enquiry by Mr. Clouston as to whether the services of the Engineer will be available for other provinces, Mr. Howard explained that the Committee were proceeding on modest lines and that the most promising avenue for the opening of this project appeared to exist in Bombay Presidency.

The resolution was accepted by the Board.

44. Mr. Keatinge next proposed that :—

"The Board endorses the drainage scheme of the Commissioner of Tirhoot and considers that it is deserving of all official support possible" ; and said there is a wide trouble in Tirhoot which cannot be tackled by individual estates, by which he referred to flood erosion. A meeting was held to discuss this matter at which all the officers of the district together with District Engineers and Railway Engineers attended, and the fact that this scheme was taken up by all hands proves the necessity of its adoption.

Mr. Mackenzie seconded the proposal.

Mr. Chadwick remarked that the Board was being asked to endorse a scheme which is purely local and unknown to the majority of the members and of which they had no details.

Mr. Morshead then explained that everything is wanted to mitigate floods and increase cultivated area in North Bihar. He said he had requests from District officials to have such scheme examined by Government, but he thought it best to consider it locally first, as they have embankment committees in each district. Proceeding further, he said that embankment does as much good in one tract as it does damage in another. There is a constant difference of opinion as to the actual benefit of one particular *bandh*. To meet the difficulty they adopted Mr. Howard's suggestion to provide drains along natural lines. To find these Sir Edward Buck's plan of survey is the best, *i.e.*, to take a settlement map and mark the lines along which water runs off the land. This, with a few levels, gives then the existing lines of drainage, but where these lines have changed they want a survey to ascertain the present water flow and to find out what changes have

occurred. They want a man to superintend the District Board's enquiry into this matter.

Mr. Chadwick thanked Mr. Morshead for the explanation and in light of the information supplied suggested the following amendment:—

"The Board welcomes the attempt that is being made in Tirhoot to carry out a scheme of drainage on a large scale and trusts that it will be thus found possible to carry out on a large scale those principles on which it is based." RES

The amendment was seconded by Dr. Barber and **accepted by the Board.**

45. Mr. Howard then proposed that—

"In the opinion of the Board any efficient experiments having for their object the discovery of the best means of increasing the duty of irrigation water should be encouraged and developed by the Agricultural Department."

He explained that he wished the Board to place on record that such experiments have their value. It is not intended to insist that they should be carried out. The resolution only suggests that these experiments might be taken up in any way which seems good.

Mr. Meggitt seconded the resolution and said that this meeting has been shown that irrigation water is often wasted in some parts while there is often not enough in others. In the cane districts of the Central Provinces there is much flooding, while a suitable distribution of the available water would result in a larger area of cane. It is open to Agricultural Departments to suggest how this waste of water might be avoided, but it was a matter for discovery how the water ran to waste. A case was cited where 97 per cent. of seepage occurred in a 9-mile long canal in the Central Provinces. By lining the canal, seepage was reduced to 40 per cent. and it is hoped to reduce it to 10 per cent.

The President, however, enquired whether this was altogether a new canal. Mr. Clouston replied in the negative and said it has been nine years in existence but not used in hot weather before and therefore lining was necessary.

Mr. Townsend thought the resolution was not comprehensive enough and proposed instead the following:—

"In the opinion of the Board any experiments having for their object the discovery of the most economical and efficient use of irrigation water should be encouraged and developed by the Agricultural Department." RE

Mr. Smith spoke of the waste of water in Black Cotton Soils.

Dr. Coleman referred to much waste of water from tanks taking place in Mysore owing to competition among cultivators for water. If properly controlled far more land would be commanded by the tanks but the Agricultural Department does not control the supply.

Mr. Howard said there must be a large amount of established facts and then the Irrigation Department can be told that they are not on the right lines. At present this cannot be done.

Mr. Brown pointed out that more water is lost in the water courses than in the fields and that if the Irrigation Department can be induced to look to their water courses much might be done.

Mr. Clouston gave instances showing how little the Irrigation Department in the Central Provinces knew of the waste of water going on.

Mr. Barnes, in seconding Mr. Townsend's amendment, referred to the Punjab canals and the loss in seepage. Contour maps show that this waste is taking place in main lines of canals. The amount of water lost in fields was almost insignificant. He thought the remedy rested with the Canal Department but the cost of lining canals was prohibitive.

Mr. Robertson Brown endorsed the fact that the Irrigation Department lose the water in canals.

The President having asked if this question was discussed in the Committee, Mr. Barnes said there was no information on this subject to form a basis for a discussion.

The President in closing this discussion said that Irrigation officers of the Punjab and the Government of India had been considering these matters for many years and a great deal of work had been done on this matter.

The amended **resolution was accepted by the Board.**

46. **The** following **report of the Committee was accepted by the Board with alterations** mentioned above. :—

It is proposed in this report to consider soil denudation (erosion) in connection with surface drainage as both these subjects are intimately related. The conservation of moisture is dealt with separately.

I.—Soil Denudation and Surface Drainage.

The occurrence of soil erosion in the monsoon-fed tracts of India is so widespread and the loss of soil—the natural agricultural capital of the country—is so considerable that it is unnecessary in this report to attempt any summary of the literature or of the notes submitted to the Board. There is very general agreement that soil denudation is exceedingly harmful and that it should be checked whenever possible.

2. *Planting Districts.*—It is a fortunate circumstance that the Board, at this meeting, included among its members a scientific officer who is conversant not only with the tea districts of North-Eastern India but also with the circumstances of the planting areas in Ceylon and Java. The Committee attach particular importance to Dr. Hope's description of the claborate systems of terracing and drainage for controlling the rain-wash on the Java Tea Estates and they accept his views as to the general adaptability of these methods to conditions in Assam and elsewhere. His report will naturally form the basis for further work on this subject in India and it is suggested that his paper be printed in the *Agricultural Journal of India* so as to have the widest publicity possible. While no doubt an increased and increasing amount of attention will be paid to the prevention of rain-wash in planting districts and to surface drainage generally, the fact remains that much irrepairable mischief has already been done which can never be removed by any system of manuring. It, therefore, appears desirable to consider, at this stage, whether something cannot be done to control planting enterprise in the future and to preserve the natural fertility of such areas. The Committee recommend that the Government of India be asked to bring to the notice of planters through the medium of the Indian Tea Association, the United Planters' Association of Southern India, District Officers and other convenient channels the fact that the serious losses due to soil erosion in the planting districts, which have taken place in the past, are to a large extent preventable. They invite attention to the notes on the methods of prevention adopted elsewhere in India in connection with other crops and particularly to the methods advocated by Dr. Hope and Mr. Anstead. Should precautions not be generally adopted in future when new areas are opened, steps may have to be taken to enforce regulations for preventing erosion, when considering the terms on which these lands are given out to planters.

3. *Other Areas.*—It will be convenient to consider these areas, which form the bulk of agricultural India, in two parts—(1) Peninsular India south of the Ganges and Jumna and (2) the alluvial tracts including the Indo-Gangetic plain and the Assam Valley. Burma was not considered separately as its soils, for the most part, fall into two groups not very dissimilar as regards the occurrence of soil erosion to (1) and (2) above.

4. Peninsular India will first be considered. In view of the fact that in Bombay a preliminary enquiry on erosion has already been completed and definite proposals have been formulated by the Director of Agriculture, the Committee considers that all the circumstances are particularly favourable for the inception of an organized attempt to deal with erosion in this Presidency on broad lines and in a systematic manner. They accordingly recommend that the Government of India be requested to place at Mr. Keatinge's disposal for a period of five years, an engineer with special aptitude for agricultural work whose sole duties will consist in the preparation and execution of schemes of embankment and drainage adapted to local conditions. These will serve both as object lesson in Bombay itself and also for other provinces. Should the scheme prove a success as there is every reason to expect it will, a beginning will have been made after which progress is likely to be rapid both in the Bombay Presidency and also in the other tracts of Peninsular India.

As regards the alluvial tracts of Northern India the position is as follows:—The results obtained by the application of the Pusa system of surface drainage, not only in Bihar but also at Cawnpore, show that by this means the cropping power of the land can be materially increased. An object lesson of the advantage of this system when applied to an indigo estate was seen by the Committee on the Dholi estate. In order, however, to make the best use of this method of drainage it is essential to regard the matter in a broad way and to consider the drainage areas of the various tributaries of the Ganges as a whole. Unless these rivers efficiently perform their functions as natural drains, the application of local drainage schemes is restricted and the best results cannot be obtained. These considerations apply with particular force to North Bihar where the natural drainage of the country is now so interfered with by embankments of various kinds that the high flood level is rising at the rate of several inches a year. The result is an increasing amount of injury to the crops, including the indigo industry. The matter is of such urgency that steps have already been taken by the Commissioner of Tirhoot to improve the drainage of North Bihar as a whole and to prevent as far as possible the recurrence of floods. The Collectors have been consulted as well as the District Boards and the evidence of the local Engineers, including the Railway authorities, has been collected. A meeting was called by the Commissioner of Tirhoot last December when all the agricultural interests in the Division were fully represented. Mr. Morshead's proposal for the immediate preparation of a drainage map of the Division was not only accepted but met with the cordial support of all concerned—the District Boards, the local Engineers, the Zamindars and the Bihar Planters' Association.

5. The Committee feel that it cannot do better than endorse this scheme which will serve as a useful object lesson for the treatment of similar areas in the plains of India.

II.—THE CONSERVATION OF MOISTURE.

6. In general, the Committee feel that the advantages of interculture and of surface cultivation generally are so well known in many parts of India and so much attention is being paid to this subject by the Agricultural Department that no general resolution on this matter is necessary. At the same time they feel that the last word on this subject has not been said and that a great deal remains to be done both to improve the best indigenous practices and also to introduce these methods into new localities.

7. The results obtained at Quetta on the saving of water in wheat growing show that even in this arid tract, where land is abundant and water scarce, a great deal of irrigation water is wasted. On every 100 acres of irrigated wheat in the Quetta valley the water lost every year could produce, if used to the best advantage, wheat and *bhusa* worth Rs. 50,000. The Committee feel that any efficient experiments having for their object the discovery of the best means of increasing the duty of water should be encouraged and developed by the Agricultural Department. There is evidence for the belief that a great deal of valuable irrigation water is being wasted in Northern India and that the present supplies could be spread over much larger areas. This would mean a larger revenue to Government, and increased opportunities for the settlement of the surplus population of the congested areas.

8. The possibilities of the saving of water in crop production are by no means restricted to canal irrigation in Northern India. Much remains to be done in working out the best duty of water in the case of tanks in Peninsular India as well as in the production of rice in several river deltas.

III.—SUMMARY.

9. Finally, the conclusions and recommendations of the Committee may be summarized as follows :—

(*a*) That Dr. Hope's paper on the prevention of soil erosion in Java be published in the *Agricultural Journal of India* in view of the adaptability to Indian conditions of the methods described therein.

(*b*) That a resolution be submitted for the consideration of the Board of Agriculture to the effect that the Government of India be asked to bring to the notice of planters through the medium of the Indian Tea Association, the United Planters' Association of Southern India, District Officers and other convenient channels the fact that the serious losses due to soil erosion in the planting districts which have taken place in the past are, to a large extent, preventable ; that the most effective measures should be taken now on existing areas and when new areas are opened. Failing this, it may be necessary for Government to reconsider the conditions on which new lands are given out.

(*c*) That the Government of India be requested to place at the disposal of the Agricultural Department of Bombay an engineer with experience and aptitude for agricultural work whose sole duties will consist in the preparation and execution of schemes of embankments and drainage adapted to local conditions.

(*d*) That the Board endorses the drainage scheme of the Commissioner of Tirhoot and considers that it is deserving of all official support possible.

(*e*) That any efficient experiments having for their object the discovery of the best means of increasing the duty of irrigation water should be encouraged and developed by the Agricultural Department.

SUBJECT X.—THE INDIAN SUGAR INDUSTRY : PROGRESS MADE IN THE INDUSTRY AND IMPROVED METHODS.

47. The Committee which considered this subject consisted of Dr. Barber (Chairman), Messrs. Annett, Barnes, Clarke, Coleman, Coventry, Leftwich, McKerral, Meggitt and Robertson Brown. The terms of reference were :—

(*i*) *The report of the Committee on Subject VII at the last meeting of the Board to be taken as the basis for discussion ;*

(*ii*) *to report the progress made in each Province ;*

(*iii*) *to recommend whether any further action is desirable at this stage.*

The report of the Committee appointed to deal with this subject as printed below (page 42) was taken up for consideration and was taken as read.

48. Mr. Barnes referring to the work of the Sugar Engineer under "United Provinces" in the Committee's report asked for details and said that machinery which was not yet proved a success should not be used for demonstration.

Mr. Hulme then handed in a paper to the Secretary which was read to the Board (Appendix D, page 91).

Mr. Barnes having asked for figures regarding working of the plant, Mr. Hulme replied they were not obtainable. A discussion then ensued as to whether the situation of the farm was suitable for the working of the plant and whether cane could be obtained locally. Mr. Barnes was of opinion that at least 25 per cent. of the cane area must be under factory control and it was because this was not the case that the experiment had not succeed d. He contended that the factory would be useful if established in a cane tract. Mr. Hulme described the prospects of the undertaking which he said were good. **The Board passed the following resolution** proposed by Mr. Barnes and seconded by Mr. Townsend :—

"The Board regret that sufficient steps were apparently not taken to ensure a proper supply of cane to the Nawabganj factory during the last two years to give the experiment a fair chance of success and can only recommend the continuance of the experiment if the United Provinces Government can undertake to obtain for the factory a sufficient amount of cane locally to keep it working at optimum conditions whether by giving advances to the cultivator to grow cane or otherwise. They consider a balance sheet showing the results of the experiment is essential in framing a judgment as to its value." Res

49. Mr. Milligan then proposed the following resolution :—

XXVI. **"The Board is of opinion that, in view of the work done and results obtained at the Kamrup Experimental Sugarcane Farm in Assam, the operations of the Agricultural Department at that farm should not necessarily be brought to a close, as originally proposed, by March 1917. They should continue till it has been sufficiently shown whether sugarcane can or cannot be grown in that tract, on a large scale, at a profit,"** and said that the programme of work at Kamrup ends in March 1917. The cane there grew well but owing to delays in arrival of steam tackle it has not been possible to adhere to the original programme. The site was selected in Kamrup with a view to exploiting new areas for extension of sugarcane cultivation as recommended by the Board of Agriculture, 1911. The district was far from civilisation and the whole of the preliminary operations were extraordinarily difficult and had to be surmounted with great labour. He considered that as the experiment seemed promising the project should be given time. In the original scheme it was only proposed to see if cane could be grown on a large scale at a price which would pay, but no one could tell what the land could do till it got out of the virgin stage and what manure will be required to replace its original fertility. Further, it was also necessary to find out whether the tackle can deal with 500 acres or more.

Mr. Meggitt in seconding the proposal paid high tribute to the energy of Mr. Birt in carrying through the initial stage of the operation and overcoming so many difficulties. In describing the original state of the area he said that the site was 17 miles north of railway out of which only 10 miles was road and the other 7 miles had to be constructed departmentally. He thought despite all these difficulties success was in sight and they only required a little more time. He was of opinion that the scheme should have been treated experimentally and not with such definite restrictions as to time, etc. He proposed that Mr. Mackenna and Dr. Butler should come and see the place and advise.

Dr. Coleman suggested dropping the word " necessarily " in the resolution to which Mr. Milligan agreed. Mr. Edwards, however, took objection as he did not want the resolution to be too definite. He said he had not yet put it up to his Local Administration and did not wish to be hampered by anything definite as after all they might sell the farm by 1917.

Mr. Milligan said that as the experiment was valuable it should not be abandoned until a definite result was arrived at to which Mr. Edwards replied that he was not bound to advise his Administration not to sell. **The resolution** as it originally stood **was** then **accepted by the Board.**

50. Mr. Chadwick then proposed that :—

"The Board recommend that the Cane-breeding Station at Coimbatore be continued under general financial and administrative arrangements similar to those which have hitherto prevailed."

He dwelt on the general success of the Station and the imperative necessity of continuing the work.

Dr. Coleman seconded the resolution and said that the results justified increased expenditure.

Mr. Howard also spoke in favour of continuing the work as the time allotted was much too short.

The Board accepted the resolution.

51. Mr. Barnes then proposed a resolution as follows :—

"The Board note with regret that the Sugarcane Station recommended by the Board in 1911 for North Bihar has not yet been commenced. In view of the facts that this tract has so far proved itself one of the most promising fields in India for the production of white sugar on a manufacturing scale and for the establishment of the central factory system on a sound commercial basis, the Board consider that a sugarcane station is of prime importance for the proper maintenance of the industry and recommend that it should be started as soon as possible."

In moving the resolution he said that the sugarcane station was urgently required. It was voted in 1911 and had not yet matured. Ten central factories were successfully working in Bihar and it was necessary to obtain a good outturn per acre of cane. The industry cannot pay for such experiments and the Government should, therefore, provide the money for the purpose.

Mr. Coventry, in seconding, said Bihar has gone ahead than any other cane producing tract. The price of *gur* is low in Bihar as it is not consumed in eating but is refined as sugar. He pointed out that Bihar offers the most promising field for central factories as the whole of it can grow sugarcane and there is no competition with other crops in the cane growing tracts. Even at Pusa, where the soil is not the best in Bihar, cane has been grown to great perfection. Much depends on better planting and cultivation and we must instruct the *ryot* who grows the cane, not the planter.

Mr. Dobbs thought some explanation was due to the Board on behalf of the Bihar Agricultural Department in connection with the resolution. Unfortunately, in the absence of the Director of Agriculture, who was ill at the time, little could be said but as a member of the Bihar Department he could say that there was nothing in the organization of the Department to ensure that any officer of the Agricultural Service would be consulted with reference to a resolution of this kind. If the Board passed this abstract resolution as it stood, it might find later on that the resolution itself was the last word that any member of the Agricultural Service had had the opportunity of saying on the subject. What he had said might or might not explain the fact that the Sugar Station recommended by the Board in 1911 has failed to materialize but he thought the Board would be well advised so to amend the resolution as to ensure that any scheme that was put forward on the strength of the resolution should receive adequate consideration from the point of view of sugarcane cultivation.

He suggested an amendment as follows to be added to the resolution :—

> " And in view of the difficulties that appear to have prevented the establishment of such a cane station hitherto, the Board recommend that the interests of sugarcane cultivation in North Bihar should be definitely committed to the charge of an officer of the Agricultural Service."

Mr. Howard said that he was of opinion that no Sugar Station was necessary in North Bihar and no special officer was also necessary at this time. There is an Agricultural Chemist in the United Provinces who has already got out a cane which might suit Bihar. What is wanted is better cane and teaching people how to grow it. There is no " loose end " officer to spare to do this work.

Mr. Dobbs deprecated mentioning any names in connection with the amendment but said that in framing it he had naturally in mind the work done on sugarcane at Sabour.

Dr. Barber deprecated the withdrawal of the resolution and said that we want a place where we can grow the cane in the district where it grows. The cultivation problem has to be tackled. The chemical work has to be dealt with and this is best done on the farm. He would, therefore, like Mr. Dobbs to combine his amendment with the original resolution.

Mr. Dobbs said that he thought the amendment would be the most effective way of getting what Dr. Barber wants.

Mr. Barnes observed that if Mr. Dobbs' amendment was added to the end of the resolution it would be effective.

The **resolution** with the addition of the **amendment** proposed by Mr. Dobbs **was accepted. It** reads **as follows** :—

" The Board note with regret that the sugarcane station recommended by the Board in 1911 for North Bihar has not yet been commenced. In view of the facts that this tract has so far proved itself one of the most promising fields in India for the production of white sugar on a manufacturing scale and for the establishment of the central factory system on a sound commercial basis, the Board consider that a sugarcane station is of prime importance for the proper maintenance of the industry and recommend that it should be started as soon as possible. And in view of the difficulties that appear to have prevented the establishment of such a cane Res X

station hitherto, the Board recommend that the interest of sugarcane cultivation in North Bihar should be definitely committed to the charge of an officer of the Agricultural Service."

52. The report of the Committee is given below :—

As no file of papers had been prepared on this subject, the first work of the Committee was to write a series of statements dealing with the progress made in the sugar industry in the various provinces. The following notes were obtained :—On Assam, Bengal, Bihar and Orissa, United Provinces, Punjab, North-West Frontier Province, Central Provinces, Bombay, Burma, Mysore and Madras. These notes contained a mass of interesting matter and showed a surprising amount of progress in various directions. They were drawn up in accordance with the terms of reference and were discussed in Committee. The following report is presented by the Committee summarizing the most important features. It is proposed that the separate notes be printed as an Appendix to the Board's Proceedings.

Bengal. In Bengal the preliminary study of the local canes has been commenced, but it is recognized by the Committee that the present conditions in the Province are not favourable to sugarcane work, and little advance has been made. The Committee regards it as necessary that a special officer should be deputed to this work under the Deputy Director of Agriculture with free powers of travelling throughout the sugarcane tracts.

Mr. Annett has made considerable progress in his study of date palm sugar and certain definite results have been obtained. It has been demonstrated that the dark colour of the *gur* cannot be remedied, as has been stated, by the replacement of the earthenware pans by iron ones, but that it is due to inherent alkalinity of the juice. By rendering the juice slightly acid *gur* of an excellent colour can be obtained. The fuel question is one of importance as it adds considerably to the cost of preparation and it has been demonstrated that coal can be readily obtained and effects appreciable saving. Attention is now being paid to the introduction of a suitable furnace for burning coal in place of wood. The day juice in the palm groves is largely allowed to run to waste as it is useless when collected for the production of *gur*, but this has been remedied by the simple expedient of liming the collecting pots.

Bihar. Progress in the sugar industry in Bihar appears to be satisfactory, but comparatively little appears to have been done by the Agricultural Department to help the planter. The note on this subject has been distributed to the Board that it may be in a position to endorse its recommendation that a separate sugarcane farm should be opened north of the Ganges to assist the planters in their work, if it desires to do so. The Committee is of opinion that such a farm is urgently needed.

United Provinces. Good work has been done in the United Provinces. Mr. Clarke has worked out details of two small crushing plants which should be of great service in various parts of the country, and has made considerable progress in the collection and testing of the varieties growing around Shahjehanpur in comparison with introduced kinds. Several of the latter have proved superior and the demand for seed is in excess of the supply.

As the Committee has insufficient information before them to show the results obtained by the Sugar Engineer during the past two years, they are unable to make any recommendations regarding this officer or the experiment now in progress at Nawabganj. The paper put in on this subject has been distributed to each member of the Board, in case the Board desires to express its opinion on the further retention of this officer.

Punjab. In the Punjab further work has been done by Mr. Barnes in the study of the local canes. It is considered that the canal colonies are unsuited to this crop and the opinion is expressed that it is unsound policy to force cane cultivation north of Karnal for climatic reasons and because cotton will ultimately prove a more profitable crop. Meanwhile, the further study of the canes of the southern areas will continue and improved methods of *gur* making introduced if they prove successful elsewhere.

Interesting details have been obtained on growing beets at Lyallpur during the past four years, but the limiting factor appears to be the introduction of good seed year by year. This is at present being obtained from Kashmir, and the results of this introduction appear to be satisfactory.

North-West Frontier Province. There would appear to be a possibility of doubling of the sugarcane area in this province (at present some 32,000 acres), new land being taken up especially in the Swat Valley, but, as the result of experiments, no cane has been found to give better results than the local thick cane of Peshawar. The beet work has been continued and the general conclusions appear to be similar to those arrived at in the Punjab.

Central Provinces. A great deal of useful work has been conducted on sugarcane in the Central Provinces. It is noted, however, that great difficulties have been encountered, owing to the failure of the local Department of Public Works in producing the quantity of irrigation water promised. In these circumstances, it is the opinion of the Committee that work should be carried on more or less tentatively until this difficulty is overcome.

Bombay. In Bombay there appears to be the probability of a very considerable extension of the sugarcane area owing to the opening of new canals. These canals run through country suitable for sugarcane cultivation and the people are anxious to grow cane there. The canals will lead to an increase of something like 800,000 acres of irrigated land, of which roughly, 80,000 are likely to be under cane. The local Department has the subject well in hand and preparations are being made to supply the necessary seed.

Madras. In Madras progress continues along the lines indicated in the report presented to the last meeting of the Board. The Cane-breeding Station at Coimbatore has done useful work and many difficulties have been overcome. A note on the subject has been placed before the members of the Board, and it may be advisable for the Board to express its opinion as to the continuance of the work, as the sanctioned period comes to a close at the end of next year. The Committee is unanimously of opinion that the work should continue.

Mysore. Considerable activity has been displayed in sugar work in Mysore both in the direction of making *gur* and the improvement of the canes grown. There are very large projects for irrigation under consideration and nearing completion. It is estimated that in the near future the existing area (40,000 to 50,000 acres) is likely to be doubled. It is also interesting to note that a large number of cane seedlings have been obtained by Dr. Coleman, and some of these are reported to be nearly ready for local trial. Great help has been given by Dr. Coleman to the Sugarcane Expert from the commencement. A number of plants, consisting of a three roller mill run by oil-engine, and battery of pans heated by an improved and very efficient type of bagasse-burning furnace (described by Mr. Chatterton) have been installed and the demand for such installations is likely to increase greatly in the future. In addition to two plants of the above description a small steam boiling plant has been set up and is being tested. The Department of Agri-

culture is engaged in introducing improvements in jaggery manufacture in smaller areas where power plants cannot be profitably used.

Assam. In Assam considerable progress has been made in the large cane farm in Kamrup, in the grass lands on the north side of the Brahmaputra. The object of the experiment is to determine whether the large tracts of waste land in this region can be utilized for the establishment of big sugar making concerns. The Committee is of opinion that the results thus far obtained are distinctly promising, but that further time will be required before the desired information can be obtained. As the area available for cane cultivation is very large, and the experiment, as at present designed, comes to an end next year, the Board will be invited to discuss the advisability of continuing the experiment for a further period. The Committee considers it advisable that it should be gone on with until definite data can be obtained for the information of capitalists. A note on the subject has been circulated to the members of the Board to facilitate discussion.

SUBJECT XIII.—FISHERIES—SHOULD THE SUBJECT OF FISHERIES BE DEALT WITH BY THE BOARD OF AGRICULTURE IN INDIA, AND, SHOULD THE FISHERY EXPERTS OF MADRAS, BENGAL, BIHAR AND ORISSA AND THE PUNJAB BE MADE PERMANENT MEMBERS OF THE BOARD?

53. The Board then proceeded to consider the question whether fisheries should be dealt with by the Board of Agriculture in India and whether the Fishery Experts of Madras, Bengal, Bihar and Orissa and the Punjab be made permanent members of the Board. The President having asked for Mr. Blackwood's views the latter said that Mr. Southwell is in entire agreement with what Sir Frederick Nicholson had said as regards the uselessness of submitting fishery programmes to the Board or to attend the Board as member. He would, therefore, propose the discontinuance of both.

Mr. Southwell said that Fishery Departments exist in Madras, Punjab, Bengal and Travancore. In the first two it is separate from Agriculture. In Bengal it is only connected with the Agricultural Department by accident. In Travancore it is connected with the Museum. He, therefore, proposed

"That in the opinion of the Board the subject of Fisheries should not be dealt with by the Board of Agriculture and further that in the opinion of the Board it is undesirable that Fishery officers in India be made permanent members of the Board." RE

Mr. Chadwick seconded **this resolution** and it **was accepted by the Board.**

54. Mr. Keatinge invited the Board to hold their next meeting at Poona the year after the next and said that he would try to obtain the permission of the Local Government in due course. Mr. Barnes said that the Punjab would be very glad to have the meeting in their province, but withdrew as Bombay had prior claim. The president, on behalf of the Board, accepted the offer of Mr. Keatinge subject to the approval of the Government of India.

55. The President next moved a vote of thanks for Mr. A. C. Dobbs (Deputy Director of Agriculture, Bihar and Orissa), who had successfully held the post of Secretary to the Board for two years. They were all grateful to Mr. Dobbs for the service he had rendered to the Board. Mr. Chadwick proposed a vote of thanks to the President who was for the last time in the capacity of Agricultural Adviser to the Government of India. They owed him a deep debt of gratitude for the many services he rendered to Pusa and the Agricultural Department.

The President in replying thanked Mr. Chadwick for his kind words of appreciation of his humble work. He felt severely the break-away from the Institute with which he had been connected from its very beginning. The Department was now growing and the scientific men had proved that they knew the job of the cultivator much better than the cultivator knew it himself. That was a sign that the Department would have great influence not only on the agriculture of India but also on her economic development. Wherever they succeeded, it was because they were given a free hand for their ideas, the only way in which scientific progress could prosper. The credit was all theirs. He parted with sincere regret, but he hoped that he would be present at the next meeting of the Board.

In conclusion, the President eulogised the services of Rao Saheb Nagarji who has been connected with the Imperial Department of Agriculture from its commencement as Superintendent of the office. His services to the Department and to the Board of Agriculture have been of exceptional value. The Board acclaimed a vote of thanks to the Rao Saheb.

APPENDIX—A.

Subject VI.—Notes on Soil Denudation, and Drainage : The Conservation of Soil Moisture.

(1)

(A. HOWARD, C.I.E., M.A., A.R.C.S., F.L.S., *Imperial Economic Botanist.*)

Soil Denudation. The whole of the cultivated area of India affected by the monsoon is subject to the loss of fine soil by rain wash. These losses are accentuated by the uneven distribution of the rainfall and by the occurrence of heavy falls which often exceed six inches in a single day. The amount of this annual loss varies according to local conditions and is by no means restricted to those areas where the slope of the land is considerable. Even in tracts of the Gangetic plain like North Bihar, where the difference of level between the high and the low lands is only a few feet, the damage done by wash is enormous and the amount is hardly realized. One of the results of this wash in Bihar has been *to remove the fine soil-particles from the higher lands and to deposit them in the rice areas.* In consequence, the fertility and water holding capacity of the high lands can only be kept up by the application of organic manures, while the thickness of the stratum of soil suitable for rice in the rice areas is much greater than is necessary for this crop. The extra soil washed down into the rice areas can be regarded as so much unproductive and lost capital.

At Pusa, some attention has been paid to this subject during the last eight years and methods have been devised to check the loss of fine soil by rains which used to take place every monsoon. The large fields have been divided into smaller areas so as to break up the run off into units and so dissipate its destructive energy. Each small field is surrounded by trenches and narrow grass borders which serve both to conduct away the run off and also to hold up the fine soil. A process of natural terracing goes on, the fields level themselves, and the loss of soil is largely prevented. Each field deals with its own rainfall only.

In addition to the loss of soil in the Gangetic plain there are many other well-known examples of denudation in India such as that on the black soils of Peninsular India and on the *karewa* lands in Kashmir. In the former case, various systems of embankments are practised to some extent, but in Kashmir nothing is done to save the fine soil of the upper terraces of the valley.

The prevention of soil denudation by rain wash in India seems to be a matter well-worth the attention of the Agricultural Department. I am aware that work is already in progress on this subject in some localities but there can be no question that it is not receiving the attention the subject deserves. Much is being done to find the cheapest manures for crops but less attention is being paid to the loss of fine soil which, if prevented, would render manure not so necessary in the future.

It is in the planting areas of the East, however, that the best examples of soil denudation are to be seen. In the hill tracts in the centre of Ceylon, an area which is now covered with the tea gardens, the original forest canopy was removed to make room for coffee which later gave place to tea. Little or no provision was made at the time to retain *in situ* the fine soil of the original forest and in consequence the loss of soil has been enormous and is still going on. The water retaining power and fertility of the tea soils of the hill regions of Ceylon have fallen off on account of the loss of fine particles and large sums are spent annually in adding green and other manures to the land. The agricultural capital of the Island has been allowed to run to waste and can never be replaced by any system of manuring. This short-sightedness is remarkable considering the local examples of terracing for rice on the sides of the valleys where the preservation of the soil has been carried to a fine art. There is no doubt that the best way in which the planting industry could have been assisted would have been by the enforcement of a regulation to terrace immediately all lands from which the forest canopy have been removed. I have heard that such a regulation is in force in Java. I am not familiar with the local conditions of the planting industries in the Federated Malay States, in Assam and in Southern India, but I understand that in several of these tracts such as the Malay States, Southern India and the Darjeeling tea tract this question of rain wash is one of the greatest importance. It is difficult, of course, to remedy the mistakes of the past by any measures open to Government, but it seems to be a matter for consideration whether something cannot be done in the future in India where forest land is sold for planting purposes. The difficulty will be to frame rules with regard to terracing which, while allowing of the development of the country, nevertheless check the destruction of the natural agricultural capital, namely, the fine soil, rich in organic matter, made by the forest. The aim should be to allow the development of the country to go on but to prevent the dissipation of its natural resources. The example of Ceylon is sufficient to indicate the damage which results in these matters from the absence of a strong guiding hand.

Drainage. In a country like India where most of the rainfall is frequently compressed into a period of about four months, the subject of drainage is apt to be disregarded. Where so much is heard about irrigation it is difficult to realize that some tracts of the country, for example Bihar, suffer from too much rain and are in need not of elaborate systems for the distribution of canal water but rather of some provision for getting rid of the excess precipitation. Drainage is also of importance in canal irrigated tracts not only in North-West India but also in such river deltas as the Godaveri where weirs have been built across the rivers so as to convert an ancient system of innundation into one of perennial irrigation.

In Bihar, drainage and soil denudation are intimately connected. The high lands are impoverished by wash and the fields below are water-logged by the extra water which drains over them from above. The system adopted at Pusa* of making each field deal with its own rainfall not only checks the loss of fine soil but also serves as an efficient method of drainage. The run-off is collected from the field trenches into larger channels which lead to the low-lying rice fields where such water is frequently welcome. If the year is one of flood, the extra water brought by these trenches makes no appreciable difference as in any case the crops on the flooded areas will be lost. Further it appears that under this system of drainage the total run-off is less than if there were no drains. By splitting up the rainfall, more of it seems to be absorbed by the upper lands than when run-off is unchecked. A *similar system of drainage to that devised at Pusa can be seen applied on a large scale in Italy particularly in Lombardy.* Great care is taken in Italy to keep the system of surface drains in order and also to cut off from low-lying areas the run off from higher lands which otherwise would convert these low areas into swampy ground.

The advantages of a drainage system in the alluvium are very great. More water is absorbed by the soil, wash is largely checked and the lower fields increase in fertility to a remarkable extent. If the low-lying areas in *North-Bihar, which now only grow poor crops of rice, could be drained, they would be among the finest wheat lands* in the world. Not only are the lower fields rendered more fertile by drainage but their cultivation can be carried out at a less cost and much more rapidly than before. The continuous wheat plot at Pusa furnishes a good example

*In order to carry out this system of drainage in practice a drainage map is essential. This can best be obtained by following *the method originally devised by Sir Edward Buck in 1870 when Settlement Officer in the Farrukhabad District. This consists in marking* on an ordinary map the directions in which rain water runs off the land. This enables the various drainage lines to be determined far more easily and cheaply than by any system of making levels.

of the benefits which arise from drainage. Previously this field was often water-logged and only gave good crops in years of poor rainfall. After being drained, the yield increased and after five crops of wheat without manure there is no sign of any soil exhaustion. The only soil exhaustion I have experienced in Bihar is that due to the loss of available nitrogen by water-logging which has been shown to produce in a single wheat crop a loss of 16 bushels to the acre (Pusa Bulletin, 33, pp. 3, 4).

The indigo estates in Bihar are now paying considerable attention to drainage and already the beneficial results obtained have exceeded expectation. On one estate near Pusa, for example, a beginning was only made during the present year when an area of about 25 acres was divided up into four fields which were also protected from the surface wash of higher land. The results were at once apparent and the owner is convinced that a proper system of drainage is the first condition in any scheme of land improvement in Bihar. If the present rate of progress is maintained, the indigo estates will soon furnish examples of the benefits of drainage in Tirhoot and it may then become a matter for consideration whether or not the improvement of the whole of the Division should not be taken in hand by Government and proper studies made of the rivers and other drainage lines. This has been done in Italy with marked success not only from the point of view of crop production but also from that of the prevention of malaria.*

The necessity of drainage in connection with scheme of canal irrigation in India is well-known but it would appear that insufficient attention is still paid to this matter. This is natural considering the time and money entailed in vast irrigation schemes and the desire of the promoters to finish the work quickly and to reduce the cost so that the project may yield high dividends. It is probable that as time goes on the Agricultural Department will be consulted in all future irrigation projects and will be able to ensure the provision of adequate drainage arrangements.

Conservation of Moisture. Experience at Pusa and at Quetta confirms the enormous importance of a proper system of conservation of soil moisture. Similar results have also been obtained in the *barani* tracts of the Punjab and elsewhere. In the alluvium, the greatest source of loss of soil moisture, while the land is under a *rabi* crop, is undoubtedly the hard surface crust which forms after rain or after the application of irrigation water. A dry surface is a necessity if the maximum crop is to be produced under *barani* conditions. Applying one irrigation to the wheat crop at Pusa does more harm than good if the surface skin formed by the water is not broken up thoroughly afterwards.

The most efficient instrument so far found for breaking up surface crusts in the alluvium and in producing a fine dry mulch for a *rabi* crop is the lever harrow. This implement is an ordinary harrow provided with a lever by which the slope of the tines can be altered at will. By sloping the tines backwards the harrow passes over a young wheat crop without injury and at the same time breaks up any surface crusts leaving a fine dry mulch behind. It has also proved of great use in the cultivation of Java indigo in Bihar during the hot season. At Quetta, its use has increased the yield of dry crop wheat from five to nineteen maunds to the acre. In Bihar these harrows have been taken up by the wheat growers and on estates where they are in use are regarded as indispensable.

Both Pusa and Quetta are good examples of tracts where dry farming is likely to be successful. At both these places the water level is less than 30 feet from the surface and in both cases the soil is alluvial in character. With a proper system of management of the surface soil and the provision of a dry mulch use can be made in crop production of the moisture which rises into the subsoil from below. It is in such tracts that dry farming methods are most likely to succeed and where the attempt can be made to grow large crops with little or no rainfall. It has been suggested that such methods might be applied in over irrigated tracts like Amritsar where the subsoil water is only a few feet below the surface and where with a proper system of cultivation good crops might be grown from the ground water supplemented by the rainfall without any irrigation at all.

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(2)

BIHAR AND ORISSA.

(C. Somers Taylor, B.A., *Agricultural Chemist.*)

The only accurate observations that I could submit consist in a series of observations on the available plant food in different parts of Sabour Farm. These observations show that the low lands in the Northern section as a rule are, as would be expected, much richer in plant food than the higher lands from which they have received the washings. I have no other definite information on the subjects brought forward by Mr. Howard, other than such as can be obtained from text-books on agriculture. That denudation is harmful and that both drainage and conservation of moisture are necessary are sufficiently obvious. Experiments on particular methods of preventing denudation, and also in methods both of drainage and of conservation of moisture, would have to be carried out as a joint enquiry by an agriculturist and a chemist. Although there can be no doubt whatever that the subjects of drainage and conservation of moisture are deserving of the closest study, in which the assistance of a chemist would be of great value, yet it would appear to me that the first two problems can be tackled with much greater ease by the agriculturist than by the chemist. The problem of the prevention of denudation, however, appears to open up a line of research from the chemical point of view which might perhaps be of profit. Such a line of investigation would be under three heads as follows :—

(*a*) How far has such denudation proceeded.

(*b*) At what rate is it proceeding.

(*c*) To what extent it is prevented by any suggested methods.

A commencement could be made of this investigation by a consideration of the soils in the immediate vicinity of Sabour which consist both of high *rabi* and low paddy land.

Such an investigation would only be of practical value inasmuch as it would provide definite information as regards the statement that a far greater depth of soil was obtained in the rice area than was actually required for the growth of the crop.

It would be practically impossible directly to measure the amount of denudation suffered by a small area. Theoretically it is simple as the only measurements involved are of the flow of water and the quantity of sediment in the water. This is easy to do in the case of the rivers but could only be measured on the land itself by digging collecting tanks which would at once upset the drainage of the area under investigation.

The amount of information gained also would not be commensurate with the trouble and expense in its collection.

Finally we come to a consideration of the prevention of such denudation by any suggested methods. These methods belong strictly, it appears to me, to the province of the agriculturist. Methods have been indicated by Mr. Howard in his note, and he has pointed out practical advantages, which have been obtained by him from their use. It is probable that practical experiments on crops, on lines laid down by Mr. Howard, would be of more use and far easier to carry out than a mere soil investigation, which, however, might be carried out in co-operation with the agriculturist.

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*Sir Edward Buck's *Report on the Control and Utilization of Rivers and Drainage for the Fertilization of Land and Mitigation of Malaria*, 1907.

I regret that the amount of actual information I am able to give you on the subject is so slight. I have endeavoured briefly to outline the directions in which investigation would have to proceed on such a subject. The enquiry is, I believe, one in which it would be impossible for me to carry out any useful investigations without the active co-operation of an agriculturist on whose shoulders would be thrown of necessity a great amount of the work, and I doubt whether the present staff of the Department is sufficiently large to cope with such an enquiry.

It is necessary, moreover, to point out that should it be thought advisable to take up the enquiry in earnest from a chemical point of view several years' work will be necessary before results are obtained, and that such results may be merely of theoretical value, as opposed to the practical information that should be obtained by the work of the agriculturist.

(N. S. McGowan, *Professor of Agriculture.*)

Drainage. On the advice of the Agricultural Adviser to the Government of India, when visiting the Sabour Farm, a drainage system was laid out by means of which each field was drained independently and the whole scheme connected up with major drains to take off the surface water to the large tank which is at the south-west corner of the farm. The scheme was completed this year, but owing to the lack of heavy rain this season an opportunity has not been afforded of judging of its efficiency. The drains round the plots were 2 feet wide at the bottom and 3 feet at the top with a depth of about a foot, and a strip of turfing of about eighteen inches was given along the side of the drains to prevent the soil particles being washed away. The plots were carefully levelled in certain areas, while other plots were left in the same condition as they were before. Although the indications of want of drainage are very clearly seen in the monsoon season very little is done in this direction by the cultivator to remove the difficulty: in fact his only effort is to make shallow drains across the width of this field after very heavy rain. It will always be observed that in a badly drained field the crop is never uniform and will always be found yellow in colour and stunted in the wet areas. It is very seldom that a field is sufficiently level to avoid depressions and water collects in consequence, and if these small areas are inspected it will be observed that the plants have either not germinated or are very much smaller and sickly in appearance than those on the better drained portions of the field. On the Sabour Farm the area which was carefully levelled and drained produced a very uniform maize crop, and no water remained in the plots for any length of time, while the crop in the fields which had drains provided round their four sides varied in colour from a light yellow to a dark green and the crop was not uniform. It follows therefore that drains round an area are not sufficient to prevent water-logging taking place but that the fields must be carefully levelled as well to get rid of the depressions which are responsible for the water standing.

There are, however, a number of points which require investigation. It is not yet certain what depths the drains should be to take off only that amount of water which can be considered as "surplus". A drain too deep and taking off water which in the ordinary course of events would have been stored and been available for the *rabi* crop would be doing a great deal of injury and rendering the soil less fertile. Again after a shower it is expected that the soil will take in all the water it requires and that only the surplus will drain away. But if the surface of the field has not been cultivated a thin crust will have formed which will help the water to flow off quickly into the drains and very little will have been taken in by the soil. Again in India where the showers are very heavy, if the plots are very large a current will run which will denude the soil of its finer particles. I think therefore that as far as drainage is concerned that (1) fields should be carefully levelled, (2) the depth of the drainage channels should be such that they only take off the water which is not required, (3) the surface of the field should be cultivated to an extent which will not prevent the water being taken in by the soil, and (4) the fields should not be very large.

There are certain areas which are practically very shallow tanks in the monsoon season but bear a late *rabi* crop. These areas are very fertile having had all the finer soil particles from the upper slopes deposited in them, but cannot produce a good crop in the *rabi* season owing to an early sowing being well-nigh impossible. As a rule the soil is a stiff clay and it is suggested that if a good slope be present "mole drainage" might be possible as it is cheap and not a difficult achievement. There is, however, the possible difficulty of more harm than good being done by draining these soils, as when once the land is opened up it loses its moisture very rapidly, but only experience will show how far it is possible to improve conditions with a view to obtaining a good wheat crop, instead of unsatisfactory crops of *khesari* or linseed which is as a rule sown in these areas.

Denudation. Apart from the surface water denuding a soil of its finer particles if the drainage of a field is inefficient the question of soil denudation will always continue so long as narrow channels are excavated in place of broad and deep ones. In those parts where channels are provided for taking the water off the land, no attention has been paid to the volume of water which will flow through the channel and the extent of the slope of the surrounding country. The consequence is that the channels in agricultural areas are too small to accommodate the amount of water poured into them and being narrow the water overflows and the strong current which is set up gradually cuts away the fields on its banks. In places where one cultivator has excavated drains sufficiently large to deal with the difficulty his neighbour by not continuing the drain has his fields flooded, and perhaps is also responsible for the flooding of a much larger area than his own holding.

The only possible means of remedying the present state of affairs would be a gigantic undertaking and entailing a great deal of expenditure. It would mean a careful survey of the country by an expert staff and the compulsion by law of the zamindars and cultivators to carry out their part of the scheme laid out by the expert. In the process of time most probably the cultivator will probably provide himself with means to save his land, but any universal scheme for draining large areas where possible must be left to the administrator.

Conservation of Moisture. Experiments in the conservation of moisture were commenced last year, and are being continued. The cultivator of Tirhoot has had a very good practical lesson in this subject from the indigo planter who was obliged to take particular care to conserve his moisture, and if a cultivator is found ignoring this point it will be because he has not either the time or the means but not because he is ignorant of the subject. But this only applies when the field is not carrying a crop. There is one operation in farming which the Bihar cultivator can be taught, and that is harrowing a crop and if possible rolling it. He is under the impression that once a cereal crop has germinated no implement except the *khurpi* or *khodali* can be worked in the field to obtain a mulch. For this reason the wheat crop when 4 inches high was harrowed and rolled last year on the Sabour Farm to show that the plants were not injured by the operations provided they were carried out when the crop was young. In *rabi* cereals the cultivator never attempts to break the thin crust which always forms although he admits that it is injurious to the growth of the crop and helps rapid evaporation and it is merely because he is under the impression that an implement passed over the young crop would injure it.

The spring-tined cultivator which is sold by Messrs. Volkart Brothers, Karachi, is always used at Sabour as it goes sufficiently deep to form a mulch on the surface, and works about 8 acres a day.

(G. Sherrard, B.A., *Deputy-Director of Agriculture.*)

There is, of course, nothing like the same amount of soil denudation in Bihar proper as there is in the more hilly tracts of India but, nevertheless, there is a good deal.

In the hilly district of Chota Nagpur the results are more serious, particularly in the cultivated, as opposed to the forest areas. All over the Division the steeper slopes and hollows are terraced, particularly in those vales

and valleys under rice that is in the great majority. This terracing checks the soil wash to a great extent, but on the more open uplands the only check appears to be that of the small *ails* between the fields, a by no means sufficient preventative.

The conditions in the Santal Parganas are much the same as those in Chota Nagpur.

In the low land beneath the Chota Nagpur hills in the Gaya district, the land is laid out in a series of large terraces and *ahars*, which system, embracing as it does a large stretch of country, checks the soil denudation to a great extent, as well as regulating the water supply.

In the low heavy rice land that occupies so large a part of the area immediately south of the Ganges the denudation must be very slight, and would usually occur only in flood time, as the comparatively high *ails* between each field must stop it to a great extent.

In North Bihar the question is rather more complicated. Roughly speaking the land slopes from North to South, draining into the Ganges, and a certain amount of washing takes place over the whole area, chiefly from the higher lands into the rice lands, which follow the various rivers, *jhils*, etc. There are, however, numerous bunds notably that of the railway, which run in various directions, and often cross the drainage line. While these are erected principally to keep off water from special areas or to raise roads and railway above the high water mark they often hold back the drainage water, and must have some effect on the denudation of the whole. This question is however a complicated one, and I have not sufficient information to discuss it either from this point of view or from the probably more important aspect of the influence of these bunds on the accumulation of water in the rains.

With regard to the question of soil drainage, as defined by the Committee of the Board of Agriculture at Coimbatore, namely the removal of subsoil water there is, I believe, no information with reference to this Province—for I know of no agricultural 'non-surface' drains.

(M. M. MACKENZIE, *Superintendent, Sepaya Farm.*)

After a perusal of Mr. Howard's note, dated Pusa, the 29th November 1913, I have no hesitation in saying that I endorse practically every word contained in the note. I may say that I have myself practised with excellent results in various parts of my cultivation at Rajaputti, and afterwards on the Siripore Farm, the conservation of moisture during the rains and at the same time the prevention of wash of the surface soil by subdividing fairly large fields into plots and surrounding these plots with small barriers a few inches high, so as to keep within each all the rain that fell naturally upon them. I must say, however, that these methods were practised only on high sloping lands which were being kept fallow during the monsoon; but the principle involved is very much the same as that promulgated by Mr. Howard. In this way, coupled with deep cultivation, I brought into cultivation at Siripore barren areas which previously had never been known to even germinate seed.

I would certainly suggest that some such arrangements might be carried out on this farm, as I think from the natural slope of the surface (which is considerable) from East to West that a great deal of the fertile surface soil is annually being washed away into the Saran Canal, undoubtedly impoverishing it to a great extent.

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(3)

UNITED PROVINCES.

(THE HON'BLE MR. H. R. C. HAILEY, I.C.S., *Director, Department of Land Records and Agriculture, United Provinces.*)

The principal evidences of soil denudation in the United Provinces are to be found in (1) the areas bordering on the rivers of the west of the provinces; (2) hill tracts of Kumaun.

In the former the process of cutting back by ravines has been going on for centuries and rendered large areas unculturable. In places the annual loss by erosion is within measurable limits and, taking a series of years, such as the period of settlement, amounts to an appreciable percentage of the cultivated areas of individual villages. Almost equally serious is the deterioration of land by washing in the vicinity. Their fertility is so far reduced by the washing away of the soil that only the most inferior *kharif* crops are grown. In this class of villages the zemindars are impoverished by gradual loss of cultivated land, and are consequently unable to devote the money and labour required to embanking and terracing.

The question of arresting the erosion and soil denudation has attracted considerable attention and various efforts have been made at different times to encourage embanking by grants of *takavi*, or to undertake the reclamation of the ravine areas by embanking on a large scale. In some cases the villagers undertake the work themselves, but it requires a corporate action which is not always forthcoming. There has been a tendency of recent years, fostered by the high price of *ghi*, for the inhabitants of these areas to turn rather to pastoral pursuits and devote themselves to *ghi* production rather than agriculture, pure and simple. This has led to a decline in protective works against erosion and probably, though this cannot be definitely shown, to an increase in ravine encroachment. The Local Government has taken up ravine reclamation in various parts of the most affected areas, primarily with a view to afforestation. The initial steps showed, that, while tree growth in such lands must be a slow matter a plentiful crop of grass could be obtained by measures of fencing and embanking which, where markets are near at hand, would repay costs of operations. It is hoped in course of time that further profits may be derived from trees, such as *babul*. The indirect advantages from such operations are obvious. Not only are the areas immediately adjoining protected from further encroachment, but the reclaimed areas afford an ample supply of fodder in the years of famine which these tracts are periodically liable. No more useful work could be provided as famine relief works than embanking and terracing. These wide spaces awaiting reclamation seem to offer the best means of solving the problems arising from scarcity of pasturage and difficulty in maintaining stock of cattle in the United Provinces. With a dense population it is hopeless to expect to save cultivable land from being broken up, but it can be very much more than made good by reclaiming eroded areas.

In the Kumaun hills the extremely profitable potato cultivation has led to the destruction of forests for potato land. As a rule this is not terraced and the results have been very much those described in Mr. Howard's note as happening in Ceylon, except that no effort is made to maintain fertility by any method of manuring. In a few years this extremely rich land becomes valueless and is often completely abandoned. In some cases efforts at terracing are made, but usually not until much of the fine soil of the original forest has been washed away. Measures have been taken to prevent destruction of forests, but much unbroken land is left to the villagers, and unless effective terracing is insisted on, the preservation of the forests will merely result in land hunger as the natural fertility of the new land brought under cultivation is destroyed.

(B. C. Burt, B.Sc., *Deputy Director of Agriculture, Central Circle, United Provinces.*)

As far as the Central Circle, United Provinces, is concerned it will be convenient to consider Mr Howard's note separately for the Doab and Oudh portion of the Circle and for Bundelkhand.

1. *Bundelkhand*. The danger of ravining and the loss of good soil which is caused by wash has been remarked on by Settlement and Revenue Officers for years past. The larger ravine systems which run to the various rivers have caused, and are still causing, heavy loss to the province whilst the soil known as Rankar for settlement purposes is chiefly comparatively high lying or sloping land which has been denuded by surface wash until little but a *kunkar* roof remains.

In all famine works in Bundelkhand for the last 7 years the making of bunds to stop wash has held a prominent place, *takavi* has been given out for small field bunds as well as for larger bunds and a number of big bunds have been constructed with famine labour after survey by the Irrigation Department. In Bundelkhand the conditions are peculiar. The sticky black soil will hold large quantities of water but beyond a certain point it becomes like treacle and runs on the slightest slope; the water level is generally low, rarely being nearer than 80 feet. This probably explains the apparently contradictory results obtained at the Orai Farm where field bunding and hot weather ploughing, at first sight operations of opposite natures, both resulted in an increase in the wheat yield probably because in each case the run-off was reduced and more rain was absorbed by the soil.

As regards moisture conserving operations during the monsoon, these in Bundelkhand are largely impossible as it is impossible to put implements on the land after the first heavy rain (except in years of extraordinarily light rainfall) until September. The main difficulty is to obtain a good seed bed owing to the tendency of the soil to form clods and this point is receiving attention.

II. *Doab*. In the Doab the water level is usually from 30 to 40 feet and is therefore lower than in Bihar. Surface drainage does in certain cases however give very marked results but is more complicated than in Bihar owing to the necessity of providing for water channels as well as drains.

The Cawnpore Farm is almost entirely irrigated by lift and it has, therefore, been possible to make the main low level water channels act as main drains. At one time the various fields were surrounded by small bunds which interfered with drainage and these were removed some years ago. One section of the farm is, on a considerable slope and catch drains across the slope, somewhat similar to the Pusa system though different in detail were put in and connected with the main drainage. The result in the improvement of the old rotation block has been most marked and figures for some of the plots are quoted below:—

Yield of Wheat in lb. per acre.

Plot No.	Average 1905-1912	Highest yield 1905-1912	1914-1915
7	1,404	1,875 (1908)	1,944
8	979	1,365 (1911)	1,094
9	1,038	1,586 (1911)	1,281
10	995	1,509 (1911)	1,190
11	1,033	1,521 (1908)	1,820
12	1,023	1,437 (1908)	1,506
13	1,024	1,386 (1906)	1,686
14	1,134	1,462 (1906)	1,956
15	867	1,365 (1906)	1,779

It will be seen that in all cases an improvement has been effected and in some cases a very marked improvement. The years 1906 and 1908 were years of light monsoon rainfall and throughout the farm irrigated wheat yields were high, exceeding 30 maunds per acre in some plots. The year 1911 was also favourable for wheat and these plots were for the first time surface drained though not on the present system. The present year has been one of heavy rainfall, both in the monsoon and in the cold weather, and in similar years in the past some of these plots have yielded less than half their present yield. The wheat yields in the present year are somewhat light throughout the farm owing to March rains and the appearance of the plots in February indicated a much more marked improvement than the above yields show, an excellent stand being obtained forming a very marked contrast to the crops obtained in previous years. The most striking improvement has taken place in plots 12 to 15 which were previously so unsatisfactory in wet years that they were cut out of the rotation experiments and used for fodder growing until the present season.

An adjoining block was similarly improved by intercepting drainage from higher land and whereas from 1908 to 1913 this field gave a steady yield of about 18 maunds per acre; this year a yield of 24 maunds per acre was obtained.

A third block of 2½ acres used for manurial experiments with cotton, also had its drainage improved by getting rid of bunds and opening up the main drainage. In 1910 and 1912, both better years for irrigated wheat than the present year, this block yielded 18·2 and 14·1 maunds per acre respectively as compared to a yield of 24·1 maunds per acre this year.

At the Kalianpur Seed Farm where much of the irrigation is by flow some difficulty was at first experienced in adapting the irrigation and drainage channels but as the levelling of the land was completed it was found that by keeping the bed of the main (high level) irrigation channels a few inches below the surface and by making them sufficiently wide, with flat banks raised only a few inches above the fields, the same channels could be made to serve as drains and water courses.

Perhaps as important as the construction of surface drains is a very elementary point in agricultural practice, *viz.*, the correct use of iron ploughs. The usual country method of ploughing round a field from the outside inwards even with the country plough produces a saucer with local water-logging in the middle and almost invariably a poor patch is to be seen in the centre of such fields. With iron ploughs used in the same way the faults are exaggerated and it is therefore necessary to teach purchasers of iron ploughs to open their fields from the centre or to use a turnwrest plough.

The application of these results to local conditions is difficult. It is easy to see that there are many tracts of land that could be greatly improved by these methods but as there are no estates possessing compact blocks of land and as all ryots' fields are small and irregular, with the additional complication of occupancy tenants' rights, progress in this direction is likely to be small until Government can see its way to acquire powers to restripe villages, align drains and water-courses and re-allot holdings as has been done in some other countries.

Conservation of Moisture. On this head there is not much to say. In the canal irrigated districts hot weather ploughing would materially increase yields and do much to assist in the control of such pests as the cane and *juar* borers and the cotton boll-worms. The result of hot weather ploughing in an average year is to reduce by one the number of waterings required by the wheat crop and often to enable sowings to be done with natural moisture which would otherwise have to be done after irrigation, thus reducing the demand for water in the season when the supply is shortest. Under the present canal rules water taken in (say) February after the removal of a cotton, *juar* or sugar crop to enable ploughing to be done is separately charged for in addition to the full rate for the succeeding *rabi* crop. If a modification of these rules were made enabling water for stubble ploughing to be taken without extra charge, there would be some prospect of introducing this practice in the irrigated tracts. In the non-canal tracts hot weather ploughing is largely a matter of cattle power and it is not at present clear that the average cultivator could do it, unless helped (as in the present year) by timely rain. In the Oudh portion of the Circle moisture conservation is well-understood and the standard of cultivation high for the implements employed.

Some small progress has been made in the demonstration of the use of lever harrows for restoring the surface mulch after irrigation and also in the use of harrows to reduce the number of ploughings during the monsoon and to enable the land to be more quickly cultivated during a break in the rains.

Mr. Howard's note also raises the question of drainage in the case of canal systems. It is now generally understood that canals cannot run across natural drainage lines with impunity and the worst cases have mostly been corrected. Isolated instances still occur but in most cases arrangements are now made for the passage of surplus surface drainage water.

Another equally important point is the local raising of the subsoil water level that occurs through seepage from the main channels. This more frequently occurs in the area between a main canal and a distributary—especially where the latter is run in a comparatively high embankment in order to give command for flow irrigation further down, and in such cases the remedy usually consists in the improvement of the main canal to reduce the seepage or the remodelling of the distributary. Generally speaking, the subsoils in the United Provinces are fairly permeable but isolated clay beds occur which are sometimes of considerable extent and which may underlie the surface at no great distance. In such cases local water-logging may be expected and this is frequently accompanied by the appearance of *usar*. This question was investigated by Mr. Leather and myself at Bhadan in the Mainpuri district on the Bhognipur Branch of the Lower Ganges Canal and as a detailed report has been published it is not necessary to go into the matter further here except to say that it was not possible to establish any close relation between the appearance of *usar* and water-logging. There was no doubt that over-saturation occurred but this may have been partly due to the fact, that the soil was originally alkaline and therefore required more water. To what extent over-saturation was responsible for the presence of *usar* could not be determined. The Irrigation Department have some experiments in progress in this tract and are paying attention to its drainage.

The risk of over-saturation due to seepage from channels and over-irrigation of the tracts of the type described would be largely diminished if the irrigation were converted from flow to lift. It is well-known that where water has to be lifted it is more economically applied than where obtained by flow, but on the other hand the extra amount of labour required in irrigation is a serious consideration and the time required to irrigate a given area is much greater. The difference between flow rates and lift rates for irrigation water does not represent the difference in value of the two supplies to cultivators by any means, but even so, the Irrigation Department state that the loss of revenue caused by substitution from lift for flow is very considerable and they also state that the management of a distributary with a large proportion of lift irrigation is much more difficult than in the case of flow irrigation. My personal opinion, however, is that there are quite a number of canal distributaries in the province which would be of more use to the country generally if they were designed for lift irrigation instead of flow.

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(4)

PUNJAB.

Letter No. 1837, dated 9th June 1915, from C. A. H. Townsend, Esq., I.C.S., Director of Agriculture and Industries, Punjab, to the Agricultural Adviser to the Government of India.

In accordance with paragraph 7 of a circular letter No. 7-50-5, dated March 25, 1914, from the Secretary to the Government of India, to the Secretary to the Punjab Government, Revenue Department, I have the honour to report to you such further information as I have been able to collect on the subject of "soil denudation by rainfall, and drainage : conservation of soil moisture" in this Province. The points on which information was needed were indicated in your No. C.1008-11, dated 12th May 1914, to the Punjab Government.

2. The enclosure to the letter, a note by Mr. Howard, mentioned five points on which information was asked for. They were as follows :—

(*i*) Loss of soil by rain wash in cultivated lands in the plains.

(*ii*) Loss of soil by rain wash in cultivated lands in the hills, terracing of fields.

(*iii*) The provision of drainage in canal irrigated tracts.

(*iv*) Dry farming for the conservation of moisture.

(*v*) Use of ground water for irrigation in water-logged tracts.

3. I deal with each of these points, in turn. As to loss of soil by rain wash in cultivated lands in the plains, it is not very important in this Province, which generally suffers from a scanty rainfall, and in which, consequently, Government has devoted much energy and money to the extensions of canal irrigation for which the Province is well-known. But there are, of course, submontane tracts, along the Himalayas : and, to a less extent, along the salt range, where excessive rainfall does damage by washing the top layer of soil away. Terracing of fields and efficient arrangements for the removal of this excess water are well understood in the hills : not so well in the submontane tracts. In years of heavy rainfall probably more damage is done in them by the excessive moisture the crops suffer from than by the actual denudation of the surface layer of soil : this former point was much in evidence at our Gurdaspur Farm this spring, where our wheats suffered greatly from excessive rain. It is not very easy to find a remedy : the difficulty is to dispose of this excess of moisture. Arrangements are, however, being made by the Deputy Director of Agriculture at Gurdaspur with a neighbouring proprietor to drain twenty acres of his land efficiently : and the results will be carefully watched.

4. I need say but little on the second point, as to damage done by excessive rainfall on cultivated land in the hills. Terracing of fields is, as just said, well-understood in them, and I do not think any further action is required.

I should make some mention of the Hoshiarpur *chos*, or mountain torrents. Hoshiarpur is a submontane district through which run torrents every few miles. In the rains these bring down much sand from the higher lands, and spread it over the rich lands of the plains, thus considerably decreasing the culturable value of this land. Government has, however, since 1900, under an Act that was passed for the purpose, taken special measures to deal with this ; the principal step taken— the reboisement of the higher areas, to prevent the soil there being washed down—has been very fairly successful. A special forest officer is now on duty in connection with the case ; and I do not recommend any further action

5. As to the third point, the provision of drainage in canal irrigated tracts, I enclose a copy of a note on the subject by the Chief Engineer, Irrigation, which shows that the matter is not being neglected here. As regards the concluding words of paragraph 8 of that note, I should mention that the *Agricultural Chemist at Lyallpur is working* at "canal seepage"—"how it arises, and how to prevent it:" and hopes soon to let us have his recommendations on the subject.

6. Dry farming for the conservation of moisture, the fourth of Mr. Howard's points, is of course one of our principal problems in the Punjab: and the Agricultural Department in this Province has devoted much time and *trouble to improve the present agricultural practice in this respect. I need only mention the use of furrow turning ploughs, which also plough deeper than the ordinary country plough, and the introduction of harrows, to be used* after each shower of rain, so as to produce a proper surface mulch, and prevent evaporation. As a corollary to this we are advocating sowing in lines as much as possible, as against the prevailing habit of sowing broadcast, especially cotton. This reform, of course, greatly facilitates interculture. A farm for dry cultivation is to be shortly put down in the north-west of the province, under the charge of a Deputy Director of Agriculture. We have to work out our own problems in this matter, and cannot entirely follow American precedent, the only precedent in the matter we have to follow at present.

7. As to the last of Mr. Howard's points, the use of ground water for irrigation in water-logged tracts, paragraph 9 of the Chief Engineer's note referred to in paragraph 5 of this letter shows that an experiment on the lines *suggested is being tried near Amritsar, where it is hoped to stop all canal irrigation, the necessary water being supplied* to the land at present canal irrigated by a series of tube wells. I understand that Government are also considering the leasing of a large area of land in the Lahore and Gujranwallah districts to a capitalist, who is to irrigate his land by tube wells to be worked by electric power derived from the waterfalls on the neighbouring Upper Chenab Canal.

(F. E. Gwyther, *Chief Engineer, Irrigation Works, Punjab.*)

Mr. Howard's assumption that "insufficient attention is still paid to this matter in schemes of canal irrigation" is erroneous and not founded on fact at least as far as the Punjab is concerned. The quotation made from his note on the subject does not, however, explain what class of drainage he is referring to.

2. There are obviously 2 classes :—

(*a*) The drainage of storm waters from the soil surface, which if obstructed would collect, seep into the soil and eventually saturate it ;

(*b*) The treatment of sub-soil waters which owing to the proximity of large bodies of water in canal or natural channels, to peculiarities of soil and other local conditions, have increased and stagnated until the subsoil water table has risen to a height unfavourable to agricultural conditions resulting in the scouring of the soil.

The first has obviously to be provided for in the design of the canal, and from the very outset of the project: the latter we have only been able to tackle as the need became apparent.

3. *As regards surface drainage, an impression does apparently exist that we have not benefited by many years* of canal experience, and do little or nothing in this direction. Nothing could be further from the truth—there is no foundation for such an idea: on the contrary, some 30 years ago or more we learnt the need for such drainage, as well as the lesson that canal projects must be drawn up on purely scientific designs to avoid subsequent trouble to the soil. The Western Jumna Canal at least taught us that in the eighties.

The result has been apparent *in all our new Canals—especially the 3 purely colony ones*—beginning with the Sidhnai (about 1885) and ending with the Triple project. In all these particular attention has been paid to drainage lines, with the result that storm waters flow unobstructed down their natural depressions, and no obstruction by irrigation or by channels is permitted in them. The provision made in this respect is not only ample—it is admirable.

4. On the older Canals—the Western Jumna Canal, the Upper Bari Doab and Sirhind Canals—the principles of their designs were based on an earlier phase of canal experience, and admittedly did not pay all the attention possible to the drainage *difficulty—to some extent I believe owing to paucity of funds. We have since been* endeavouring to rectify the defect; on the Sirhind Canal (the most modern of the 3) we take the opportunity afforded by every year of abnormal rainfall to examine conditions, to see where they result in inefficient drainage and to rectify them.

The same action is taken on the Upper Bari Doab Canal, where considerable drainage improvement has been effected since the notably wet year *1908 revealed many deficiencies. Prior to that the distributary system had been* remodelled with a view to setting free lines of natural drainage.

5. *It is, however, on the Western Jumna Canal that the largest measures were taken, and the greatest improve*ments were effected: that they were needed, the deplorable previous condition of the tract it irrigates only too obviously evinced. Its insanitary saturated condition 30 years ago formed a blot on irrigation practice of the time.

By opening up all low lying lands, creating main and lateral drainage lines along drainage bottoms, and keeping them open always, the free flow of surface (and in some cases of subsoil) waters has been secured, with great resulting *benefit to the health of the population.* Our endeavours have secured a net work of drainage lines all over the tract and surface flow off is not now obstructed. There are still some minor errors which need rectification—further improvement is possible, and we are giving it our attention.

I have dwelt at some length on this Canal, because its drainage defects had been so glaring, while the improvements in them were on such a large scale and have produced such satisfactory results, as to constitute an object-*lesson in the subject.*

6. As regards subsoil drainage, having for its object the removal of excessive seepage into the soil and the lower*ing of its internal water table, our attention has, as I remarked above, been confined to sites in which soil de*terioration is visibly imminent. There are many cases in the Punjab where we have endeavoured to attack the evil—with varying success: I need only mention a few :

The Khadir drains on the Western Jumna Canal arou . and below Indri; the Mach wara Khadir Drains on the Sirhind;

seepage drains on the Main Line and Lahore Branch of the Upper Bari Doab Canal;

a similar drainage system on the Main Line, Lower Chenab Canal.

In all these cases our artificial drains do remove excessive seepage out of the soil—so accomplish results of some benefit: but they are costly, need incessant attention, and do not secure any progressive improvement in the direction we desire.

7. Under this head too we might differentiate between two possible processes, *viz.*, operations—

(*a*) for removing excessive water from the soil thereby lowering its height and decreasing saturation;

(*b*) for decreasing the flow into the soil from our large canal channels and thereby securing similar results—the two standing to each other in the relations of remedy and prevention.

Under the former are included the seepage drainage channels to which I alluded in the previous paragraph—their effects are distinctly limited, and the alternative *to them as far as our* present experience and knowledge go is the latter.

8. Here too we have during the last 5 years endeavoured to secure a solution. The problem is to so staunch our leaking channels by some impervious media as to sensibly diminish seepage into the soil. We take it in this case as in others that prevention is better than cure, but we have to deal with such large bodies of water, such big channels that an economical solution is, we find, by no means easy.

Nevertheless progress on definite lines has been secured—mainly on the Lower Chenab Canal to a smaller extent on the Upper Bari Doab Canal, we have lined some miles length of our big channels, with cement or with puddle, and the results are economically good : the many experiments we have made tend to indicate that these linings do very sensibly diminish seepage into the soil, and therefore constitute work based on sound lines ; its cost so far proves it to be also an economical proposition.

The line we are now taking is to start at the beginning and endeavour to obviate that leakage into the soil which renders necessary such inconvenient arrangements as seepage or subsoil drains. The problem is, however, in its initial stage, and I have no doubt that its solution would be greatly benefited and pushed on if we could secure the collaboration of scientists in the Agricultural Department. So far we have been favoured with no suggestions—our progress and intentions are based on results secured from parallel experiments conducted in America and here.

9. A further effort we have lately embarked on with a view to improving the deteriorated subsoil conditions lies in the direction of substituting for irrigation by flow from a canal, the use of ground waters pumped up through suitable tube wells. An experiment on a fair scale has been sanctioned in the vicinity of Amritsar, where the soil water is unhealthily high: the installation will seek to utilise it in the interests of agriculture thereby preventing the accretion of fresh seepage water, and ultimately we hope to lower the water table definitely and sensibly. If it proves a success its extension to other similar areas will obviously be undertaken in the near future.

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BOMBAY.

Letter No. A-246 of 12th January 1915, from G. F. Keatinge, Esq., C.I.E., I.C.S., Director of Agriculture, Bombay, to the Agricultural Adviser to the Government of India.

With reference to Resolution No. VIII passed at the last Agricultural Conference, to your No. C-1008-11, dated 12th May 1914, to the Government of Bombay and to their orders on the subject. I have the honour to forward herewith a note which I have prepared on the subject of soil denudation in the Bombay Deccan.

2. As regards drainage the matter applies to this Presidency only in the canal tracts and is of a special nature. It has been the subject of discussion in this Presidency for some years past, but is mainly an engineering question. There is no question regarding its desirability but only regarding its cost. I am not in a position to forward any general information of a useful nature on the subject.

3. As regards the conservation of moisture in the soil, there can be no doubt that in this Presidency as elsewhere good cultural methods tend to preserve soil moisture. They are extensively practised by the cultivators of this Presidency and with good results. All good cultivators in the dry tracts interculture their crops during breaks in the rains so as to conserve the moisture ; unirrigated wheat is frequently grown on well-prepared lands without the advantage of any rain after sowing time. Very successful cultivation of the same nature is carried out in the beds of some tanks after the rain has ceased and the water has been let off or dried up ; and the cultivation of *bori* lands in Sind which has already been described by Mr. Henderson is a good example of the same practice. We have tried typical dry-farming methods on heavy black soil in the Ahmednagar District and have found that with fair rainfall they are distinctly beneficial. In a year when we received only 10½ inches of badly distributed rainfall, however, our crops, both *kharif* and *rabi*, failed completely, in spite of all our efforts to conserve the moisture. In my opinion the matter can be considered only with reference to the physical qualities of any particular soil and in particular with reference to its powers of storing, retaining and bringing up to within reach of the root system of the crops grown the moisture so stored. These properties vary enormously in different soils. I may mention the case of two neighbouring tanks in the Poona District the beds of which are leased for cultivation in the dry season. Both have deep deposits of earth which has been washed into their beds. In one case the soil is a heavy black soil which cracks badly when the tank is dry, its cultivation is difficult and the results obtained are moderate to poor. The right to cultivate the bed of this tank is leased annually for about R. 1 per acre. In the other case the soil is a very fine red-brown silt with excellent capillary powers. After the water has subsided one excellent crop and sometimes a second can be grown without any rainfall. The people pay as much as Rs. 32 per acre for the right to cultivate this for one year.

I believe that a systematic soil survey and a thorough study of soil physics would yield very interesting results in this Presidency ; but till the study is made it is not possible to express any general opinions of value.

Note on Soil Denudation in the Bombay Deccan.

(G. F. Keatinge, C.I.E., I.C.S., *Director of Agriculture, Bombay.*)

Soil Denudation. The evidences of soil denudation in the Bombay Presidency are to be found in the bare rock surfaces visible on the tops and sides of high hills, low hills and even slight elevations in the *murrum* (half disintegrated rock) surfaces so common in similar localities, in the complete absence of surface soil on considerable areas sloping down to rivers and *nallahs* where the rush of water has laid bare a surface of rock, *murrum* or hard lime substratum. They are also to be found under circumstances which, though less obvious, are even more important from an agricultural point of view in the very thin soil of undulating uplands from which a steady wash occurs year by year throughout the field, and in the scouring and washing in well-marked tracks that can be seen on all sides in the deeper, low-lying soils wherever the surface is not approximately level. In these cases the surface water as it gathers forces towards the lower side of the slope, scours deep into the soil in the folds of the slope, or, if the force be not sufficient for this, carries with it the fine silt and leaves behind a track of pebbles, sand, nodules of lime and other substances which are less readily removed.

2. In this note no reference is made to Sind where the light rainfall as a rule does little damage, nor to Gujrat where the flat alluvial plain is comparatively little subject to scour. In the Konkan and the strip of country immediately above the ghats where the country is hilly, the soil light, and the rainfall heavy, rice is the chief crop of the low-lying lands. For rice cultivation the country has been terraced and embanked, often at great cost and with much ingenuity, and improvements so made are for the most part kept in fair repair since their maintenance is essential to rice cultivation. In this tract the chief object is to control the water, and it is in most cases only incidentally that denudation is arrested or silt collected. No doubt there is still much to be done here in obtaining a better control of the surface water, but the physical difficulties due to the rush and volume of the surface water, and the economic difficulties due to the smallness and fragmentary nature of the holdings are such that it is very difficult to generalise or to say that any wide-spread improvements could be introduced without incurring a cost out of proportion to the advantage gained, and in this tract such improvements can be projected only on a detailed consideration of each particular case. It is, therefore, proposed in this note to consider the problem only in the Deccan and Southern Maratha Country, omitting the strip lying to the immediate east of the Ghat line.

3. The cultivators of the Deccan and Southern Maratha Country are aware of the advantage of field embankments and recognize the loss that is caused to them by surface washing and soil denudation; though perhaps they do not realise the full extent of the loss. The problem varies in different localities. On the Western side it is common to see sharply sloping fields, in which *bajri*, pulses and the lesser millets are grown, roughly embanked with small stone ridges which serve to check the force of the surface washing and which hold up the soil to some extent, thus producing modified terraces which, though not level, tend to become so. In the valleys the better cultivators have in places made excellent field embankments to stop wash and to collect the silt. In places the boundary of a sloping field may be seen embanked to a height of 10 feet and pitched with stone for support. Such works are, by no means, general but are sufficiently common to afford object-lessons to any cultivator who wishes to improve his land.

4. As regards field embankments, the largest and by far the most important tract to be considered is the East Deccan comprising the Ahmednagar, Sholapur, Bijapur and Khandesh Districts, the eastern parts of the Nasik, Poona, Satara, Belgaum and Dharwar Districts and the Native States whose lands fall geographically within this area. Here the physical conditions are different from those of the western tracts. The soil is, for the most part, heavier and deeper, in many localities long undulations take the place of the steeper hills, and the rainfall is less plentiful and constant, though it occurs from time to time in heavy falls which may amount to 5 or 6 inches in a few hours. These heavy falls, which occur chiefly in the months of August to October are so welcome in providing the moisture necessary for the *rabi* crop that the general tendency is to condone the damage which they do to the lands; but this damage is very considerable. The water rushes over the slopes taking with it the fine silt, and most often, I think, in a single heavy fall remove from the land more plant food than is consumed by the growth of an ordinary crop. The lower parts of the fields are scoured into deep furrows, and little attempt is made to repair damage which may recur in a few days' time. The position is worst where there are long slopes which enable the water to acquire volume and velocity but, even in a field where the undulations are small the surface may often be seen so scoured that a third of the field may be rendered completely useless, and that too the lowest part of the field which obtains the most water and which should in a dry tract produce the best crop. In this large tract the extreme importance of field embankments is undoubted, but except in limited areas the extent of land which is efficiently embanked is almost negligible. The question has, however, received some attention both from Government and from the better cultivators and an account of their efforts will be given.

5. Apart from the fact that loans are advanced to cultivators under the Land Improvement Act for the construction of *tals* (field embankments) the value of this form of work as famine relief has been recognized by Government. The matter was brought prominently to notice in 1905 by Mr. J. P. Orr, then Collector of Ahmednagar, who in November 1905 submitted a detailed note on the subject explaining the advantages of *tals* in checking erosion, the suitability of this kind of construction for small famine relief works and the general principles on which they should be constructed. Government decided that *tals* "are probably the most useful and practicable kind of village relief works that have yet been devised," and made Mr. Orr a grant for the construction of *tals* in the Ahmednagar District, and asked the Collectors of other districts affected by famine to undertake this kind of work where possible, and in 1907 instructions were issued by Government in the Public Works Department regarding the principles and design to be observed in the construction of field embankments combined with terraces and boulder weirs on *nallas*. Some specimen *tals* have been erected in other districts by Public Works Department agency, but since that time there has been little demand for famine relief works and little construction of this kind seems to have been undertaken except in the Ahmednagar District where the work was energetically started by Mr. Orr, and continued by his successors. In 1907 as a result of the Report on the "Control and utilization of rivers in Italy for the fertilization of land," by Sir E. Buck Government decided to continue the experiments in Ahmednagar, laying down the following principles for the continuance of the work :—

(1) Trenches or lines of loose stones along contours of hills.

(2) Dams of small stones across hillside rills and bigger stones across small *nallas*.

(3) Boulder dams across big hillside *nallas* and *nallas* below the hills; these lead ultimately to the terracing of the stream beds.

(4) Temporary dams in streams, some with and some without permanent foundations, waste weirs and irrigation channels.

(5) High earthen embankments with stone pitching across lines of drainage on gentle slopes to form small tanks.

(6) *Tals* (field embankments) of earth and stone.

The reports on these operations submitted in 1910 and 1911 showed that many of the embankments made had breached, that as a business proposition the cost of departmental construction was far in excess of any practical advantage likely to be derived and that in point of fact the advantages derived were very slight.

6. I had an opportunity of visiting some of these *tals* in 1911 and my general impressions were as follows :— Mr. Orr had made a point of the fact that the series of embankments must be begun near the top of the slope and carried on down the slope after the water higher up has been got under control. This no doubt is a sound proposition, but the advantage of the *tals* will not be obtained to any considerable extent until the series of *tals* has been extended to the lower lands. In the present cases the *tals* had been constructed in some cases along the contours of steep bare hills which were hardly susceptible of any considerable improvement, and the advantage of controlling the run-off had been obtained only to a slight degree, since the embankments had breached in many places. The experience gained was interesting in some details, but it was clear that with hired labour such *tals* were not likely to be remunerative and that the matter was essentially one for the private enterprise of a land owner thoroughly acquainted with the natural conditions in time of heavy rain and who could not only construct the work at little expense in his spare time but who would be on the spot to keep the construction in order from year to year and to strengthen it in time when necessary. These Government constructions gave evidence of the inevitable lack of detailed knowledge of exact local conditions, of the prohibitive cost of departmental construction and of the necessity for the interested party being on the spot in time of heavy rain to keep the dams in repair. Apart from this the position of these embankments in Mr. Orr's scheme, constructed as they were on steep hill sides, was that of preliminary operation to check the force of the flow and make it possible to construct a further series of *tals* and embankments further down on the more level and better lands which were susceptible of being converted into valuable agricultural fields. Since these further *tals* and embankments had not been constructed lower down the value of the preliminary line of defence was in great measure wasted. I think that the situations selected were in some cases too difficult for such experimental works. It is true that the steeper the hill and the greater the scour the greater is the necessity for protection, but the difficulty is also greatly increased in such cases. I have quite recently had an opportunity of visiting a series of contour *tals* that were departmentally erected five years ago, a few miles from Ahmednagar, on a moderate slope at the foot of some bare hills. Three lines of low earthen embankments had been erected along the contours, and the *nalas* had been dammed with boulder weirs, so that the flood water might flow along the contour embankments and deposit silt. In some places these *tals* had breached, in other places no silt deposit had occurred apparently because the contour lines were not quite level, but in other places large deposits had been obtained, sometimes of fine silt and sometimes of coarse sand and grit. This example seemed to show that the result aimed at could be obtained but not without sustained care and attention. There are large tracts of long undulations where enormous damage is annually done by scour but in which the run-off can be controlled with much less labour and risk. It is such situations that cultivators usually select for their efforts in this direction, and some account will now be given of their operations.

7. I have had opportunities of noticing the effect produced by the *tals* constructed by cultivators in the Sholapur and Bijapur Districts both in the monsoon and in the cold weather, and remember observing that in the

famine of 1899-1900 in some parts of the Sholapur District it was only under the *tals* that any crop at all was obtained. In ordinary years the *rabi* crops are greatly benefited by the presence of *tals*, and the cultivators are accustomed to express the advantage by saying that the crops in these embanked lands are equal to *bagait* crops. There are places in these districts where the shallow valleys in the long undulations have been traversed by a series of *tals* and a strip of country which formerly consisted of a *nalla* at the bottom with scoured slopes on either side has been converted into a smooth strip of excellent agricultural land which year by year collects additional silt, profits by the water which slowly filters through and retains for the benefit of the crop the plant food contained in the soil. The *tals* themselves consisting of high embankments of good soil are often sown with the seed of *nim* trees which send down deep roots into the loose soil and profit by the moisture held up, producing a very good growth of timber and serving to consolidate the embankment.

8. In 1910 I circulated a short note on *tals* and asked some District Officers to give me an account of *tals* in their charges. The following summary contains the information received :—

Ahmednagar District. Earth *tals* strengthened with stones and good earth *tals* with waste weirs constructed of stones hardly ever breach, but in time of very heavy rain hardly an earthen *tal* escapes breaching. The water level in wells below *large tals* is materially raised. If stone is not available *tals* are made of a mixture of earth and *murrum* or of earth and *murrum* in alternate layers. As the soil above the *tal* becomes raised by accretions of silt the height of the *tal* and of the waste weir must also be raised. Stone is not always available in black soil areas.

In Rahuri taluka an instance is given of land worth Rs. 400 which was improved by a *tal* costing Rs. 1,000 and is now worth Rs. 2,000.

Eight villages are mentioned in the Sangamner taluka which contain good series of *tals*.

Sholapur District. In the Karmala Taluka small *katcha tals* are common and some large *pakka tals* exist. An instance is given of a series of three *tals* constructed of earth and stones and fitted with stone waste weirs, built six years previously on a long gradual slope, which had much improved the land, and had converted a strip of stony, scoured land into a fair to rich arable field.

In the village of Akola (Karmala) a very good *tal* has been built by Eknath Patloji Patil. It is 500 feet long built of stones and *murrum*, with a *pakka* stone waste weir. *Nim* trees were planted along the *tal*. Since the erection of this *tal* six years previously, 2 to 3 feet of silt had been deposited converting the land from a very poor to a very rich one. The land (17 acres) was purchased for Rs. 120 and is said to have yielded a net annual profit of only Rs. 20 previously. The cost of the *tal* was Rs. 1,200 and the value of the land is now said to be Rs. 3,000 yielding a net annual profit of Rs. 300 to Rs. 400.

A good *tal* is mentioned at Surli (Karmala) built 12 years ago by Abaji Appaji Patil. It is 1,500 feet in length and cost Rs. 2,200. The field (15 acres) in which the *tal* was constructed formerly gave a gross yield of Rs. 75 to Rs. 100. It now gives a gross yield of Rs. 500 to Rs. 600. Silt to a depth of 5 feet has been deposited above the *tal*.

In the Pandharpur sub-division of the Sholapur District a list of 48 villages is given where *tals* have been constructed. An instance is given of S. No. 33 of Sangola where a *mal* land worth Rs. 100 previously, much scoured and unfit for cultivation, was much improved by the erection of *tals* costing Rs. 725. The value of the field is now said to be Rs. 1,600.

Akalkot State. The Administrator sends a design for a scheme of *tals* which has been introduced on the private estate of the Raja of Akalkot and copied by some cultivators. *Tals* 400 feet long and fitted with waste weirs of large stones are erected on long slopes 300 feet apart. The earth and *murrum* are taken from burrow pits excavated 20 feet above the *tal*, which subsequently fill up with silt. Three such *tals* are said to have been erected in a 10 acre field (the whole costing Rs. 150) and to have greatly improved the land.

Bijapur District. In the Bijapur District a series of *tals* (known in Kanarese as *wads* or *arnis*) may be of much utility, but some large *tals* costing from Rs. 2,000 to Rs. 8,000 have been erected which will not repay the cost of their construction. Many *tals* have waste weirs, but in some the water is merely diverted and flows round the end of the weir, possibly on to another man's land, and in time of heavy rain this is apt to cause many disputes.

Many isolated patches of land are terraced in the Hungund Taluka, especially in Kundgol and Gudur. Some very profitable terracing work was noticed at Chennapur in the Badami Taluka. *Tals* constructed by the owner seldom cost more than Rs. 100, but a work constructed by hired labour costs far more and large sums of *takavi* advanced for this purpose produce little proportionate effect. Some men construct waste weirs, while others merely divert the course of the water, sometimes into their neighbour's fields, which causes disputes.

Intelligent cultivators agree that what is required is a series of *tals* down a slope so that the ones higher up break the force of the water. They often talk of combined action but seldom effect it. Consequently it is most common to find a large *tal* built far down the slope. In Indi Taluka a cultivator spent Rs. 300 on a *tal* and his land is said to have doubled in value in consequence.

At Basnal in the Indi Taluka there are some very good series of *tals*, and the fields are kept clean and well cultivated and grow good crops. *Nim* trees are planted on *tals* to consolidate them and to provide fuel. Aloes and Lakki (*Vitex negando*) are said to be good shrubs to plant for consolidating earthen *tals*.

Poona District (EAST).—*Tals* usually consist of earthen banks, thrown up very carelessly, which breach easily. Only knows of one fitted with a waste weir built of stone.

Considers *tals* as unsuitable objects for grants of *takavi*.

West Khandesh. Mentions a *tal* at Shelti in the Nandurbar Taluka, 75 feet long and 15 feet high faced with stone on the upper side and strengthened with stones at the ends. It costs Rs. 125. The silt collected has filled up depressions and added a foot of soil to the land above the *tal* in the course of two years. The water which collects above the *tal* is led off to the land below which is protected from scour. The land has greatly increased in value in consequence of the *tal*.

Mr. P. J. Mead, the present Collector of Ahmednagar, who has kindly revised this note, sends me the following additional information :—

"The *locus classicus* for *tals* here is Akola. I divide them into three classes :—

I. *Tals* converting *nallas* into terraces.

II. *Tals* to hold up water for *kharif* and in good years some *rabi*.

III. *Tals* to prevent scour.

Of course one class fades into another at times, but you can generally differentiate them easily. Rainfall and tract do not necessarily condition the class of *tal* you find. Class I represents the best attempt at *bonificazione* I have ever seen or heard of in India. You won't find this in the absolute ghat village with 200" rainfall but you will find it both in the Dangs and Desh parts of Akola (rainfall 60" and 25", respectively). The essentials appear to me to be Thakars for construction work, capital, a good but not too violent flow of water over hills that are not too bare already, and a little enterprise. I am told that terraced lands formed in this way never need manure and I have seen sugarcane grown on them, as well as all the better *rabi* crops. The best specimens are old works which have reclaimed big ravines about 2 miles in length but I have seen new ones in course of construction, so the art has not died out.

I have persuaded the Forest Department to begin leasing such lands in Forest and the demand for rocky *nallas* was very keen indeed. All have waste weirs and the Thakars seem to know their job thoroughly well. At times they make mistakes or a very heavy flood comes, and then a *tal* goes. The *tals* are mostly made of stones and earth,

with stone only at the waste weir or of rocks where a very large and strong dam is required. I was told that some of these "systems of *tals*" had cost Rs. 10,000 but the work is always gradual and continuous. I am not sure that they *always* begin at top or bottom. My recollection is that they generally began with a big dam fairly low down. Note that in these cases there is no quarrelling with neighbouring owners as a rule, and they must have the hill sides close to the *nala* to scrape soil from.

Class II are found in Akola, Desh and Dangs and also in West Parner and Sangamner. We don't grow much rice, except in parts of Akola, but *bajri, jowari*, pulses, a little gram in good years seem to be the usual crops. Not uncommonly a small watercourse is dammed up as in Class I but the land is less steep. I note here that a Rs. 200 *tal* at Gardani 317 feet long by 8 feet broad and 15 feet high (stone) looks after 2*a*. 14*gs*. of land, while two smaller *tals* (earth) costing about Rs. 20 and Rs. 30 each look after another 25*gs*. Yearly crop valued at Rs. 100.

At Ambad 5 *tals* look after 2*a*. 31*gs*. crop averaging Rs. 60. *Tals* vary in length from 165′ to 264′ and 7′ to 10′ in height.

Another series of 7 *tals* suffices for 2*a*. 22*gs*. on which is grown a crop worth Rs. 80, more than half rice. *Tals* 99 to 231 feet long and 5 to 16 feet high.

All these are between hills and have streams running through them which they regulate. They are well kept up *because it is essential to do so*. Small holdings prevent development of the system.

Class III everywhere, but only kept in good order *under economic compulsion*. Where land is scarce, damage to unprotected fields considerable and labour cheap or small holders hard-working, the practice is almost universal. To the East considerable damage by scouring is common and field embankments ought to be far commoner."

9. *In the foregoing note I have divided the country under consideration roughly into West Deccan and East* Deccan, on a consideration of the general differences in soil and rainfall which is common to each of these tracts, but of course, many marked physical differences occur in different parts of these tracts. Perhaps the most marked physical difference is in the soil of parts of the East Deccan. I have assumed the soil of these parts to be a heavy black soil, which is the general characteristic, but there are parts notably in the South of the Dharwar District, in the Malegaon Taluka of the Nasik District and in the Dhulia Taluka of West Khandesh, where there are large areas of deep, light soil which consists of a medium to sandy loam. In such conditions the evil effects of scour are intensified, while *per contra* the beneficial effects of embankments are very marked, and the silt-laden water deposits thick layers of silt wherever the flow is effectively checked. Round Gadag, Dharwar District, some very profitable works on moderate slopes have been undertaken by owners of land, which usually take the form of low broad earthen embankments fitted with a slightly raised stone channel in the course of the stream. As the silt deposits from year to year the level of the stone channel and the height of the earth embankments is raised, and a deep layer of silt is collected at small cost over a considerable area, to the manifest advantage of the crops. In the Malegaon and Dhulia Talukas operations of this kind seem to be almost unknown though they offer a vast field for profitable enterprise.

10. To sum up the general lessons derived from the enquiry, the objects with which field embankments are or may with advantage be constructed are :—

(1) To reclaim stony *nalla* beds slopes in suitable localities. This corresponds to the Italian *bonificazione* and is best exemplified by the Akola practice ;

(2) To improve sloping fields liable to scour by obtaining a deposit silt above the embankment ;

(3) To protect from scour the land below the embankment by holding up the water entirely, by breaking its force or by diverting it to another course. This may be useful in the case of deep soil ; but where the soil below is shallow or has been badly scoured it cannot be much improved without a deposit of silt ;

(4) *To retain water which will benefit the crops where it is held up, and which may in the case of large tals* raise the water levels of wells below.

11. *The chief principles which it is necessary to observe are :—*

(1) The *tals* must be made strong enough not to breach. Carelessly made earth embankments constantly breach in time of heavy rain.

(2) For effective work where the flow of water is considerable some stone pitching is desirable, and stone waste weirs are almost essential. These stone weirs are generally made towards the sides of the embankment, but where the flow of water is not very great a small raised stone channel in the middle may suffice, as is constructed in the Gadag Taluka.

(3) Care should be taken not to divert the waste water into another man's field, since this causes disputes.

(4) Where the subsoil is impervious and an excess of water tends to accumulate above the *tal* a pipe should be run through the *tal*. This should be kept plugged till the silt has been deposited and the clear water can then be let off gradually.

(5) A series of *tals*, large and small, is the most effective system, and is much to be recommended where it can be arranged.

(6) It is best to begin *the series fairly high up on a slope so as to break the force of the water before the flow* becomes very large, but if the work is begun on a steep, bare slope it is likely to be costly and ineffective.

(7) *Tal* making may with advantage be combined with well making. The well provides stone for the *tal*, and the *tal* adds to the water supply of the well ;

(8) *Nim* trees planted on *tals* provide timber rapidly and consolidate the earth work.

(9) It is desirable to consider the quality of the silt likely to be deposited. A torrent from a rocky hill will bring little but grit, which may be of little benefit to a soil already light, though it might improve a heavy black soil considerably. The flow from cultivated fields naturally brings good and fine silt and a deposit of red silt on a heavy black soil sometimes produces an admirable mixture.

12. The conditions which favour *tal* construction are :—

(1) Economic pressure of population on the land.

(2) Cheap and effective labour, *e.g.*, the Thakars in Akola who have reduced this work to a fine art.

(3) Plenty of loose stones for construction.

13. As regards the question whether *tal* construction is financially profitable it appears that—

(1) In suitable circumstances even large *tals* costing several thousand rupees and constructed by hired labour are often successful ;

(2) Small *tals* properly constructed often bring in very good profits ; and where conditions are favourable and the land owner is a careful, hardworking man a *takavi* advance of a few hundred rupees may often be well-justified financially. A large advance to a poor man, however, for this purpose can hardly be recommended.

(3) Some of the very elaborate embankments costing up to Rs. 8,000 will probably not give a good return on the outlay but are quite a satisfactory operation for a well-to-do man who takes a pride in his land and is prepared to indulge his taste in this way.

(4) Departmental construction is always costly and frequently ineffective, and cannot be recommended, except as a famine relief work; and even in such cases it is desirable to select spots where the flow of water is not very great, since difficult situations require yearly attention, which may not be forthcoming in such cases from the land-owners.

14. *Encouragement can best be given to tal building in the following ways*:—

(1) By technical advice and assistance to land-owners given by the Agricultural Department in localities where the operation is not well-understood;

(2) By moderate advances of *takavi* in suitable cases;

(3) By inducing neighbouring land-holders to co-operate, here necessary for a series of *tals*;

(4) By giving out *nallah* beds and slopes situated in forest lands in localities where the art of reclamation is understood and there is a desire to undertake it.

15. I have dealt with the matter at considerable length because I believe that improvements of this kind must play a very important part in the effective development of agriculture in the Deccan, whether they be regarded as a means of improving the soil of poor uplands or of maintaining the soil of the deep low-lying lands. They are suitable enterprises both for the well-to-do-man who can find the capital and afford to take some risk, and also for the poor land-holder who can in this way utilize some of his spare time in the off-season.

16. I append a note prepared some years ago by Mr. H. F. Beale (now Chief Engineer for Irrigation) giving technical advice on the subject.

(H. F. Beale, M. Inst. C.E., *Superintending Engineer, Southern Division.*)

The *tals* here dealt with are intended to serve as important structures to arrest erosion. They are suitable for use in *nallas* or wherever water is likely to flow.

Ordinary field bunds can be made of earth and *murum* with side slopes of 1½ to 1 or 2 to 1, and the stone *tals* would be used only at the end or ends around which the water would flow. It is important to arrange for the discharge of flood water, however little it may be, in all cases of bund construction.

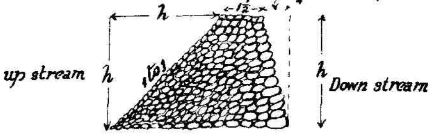
Stone *tals* will arrest sand or silt (earth) brought along by the water.

The design is of importance. It has been stated by some that the agriculturist cannot be taught much in connection with *tals*. This is in my opinion a great mistake. It is not difficult to construct a *tal* strong enough to stand the usual small depth of water headed up, and the failures in this respect are few. But the arrangements for passing off surplus water are usually faulty and the very numerous failures all over the Deccan can in almost every case be put down to *deficient provision for floods. A tal, bund*, grid or obstruction *of any kind* must always have a byewash or flood opening of ample size and strong enough to withstand the scouring action of the water. It would not be difficult to prepare a table giving the necessary width in feet for catchment areas of various sizes as a general guide.

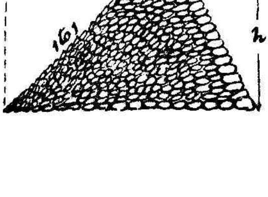
Small *tals* can be constructed as ordinary banks and no surveys are necessary, but a few levels would be useful for the larger works, and for all works in *nallahs*. I attach a note on the construction and approximate cost of *tals* at normal rates, which may be of use. It may be stated here that professional advice is necessary to show where the larger *tals* can be safely erected. They present little difficulty in ground with a good slope and hard substratum, but in the flatter black soil areas they require very careful consideration and designing.

Rate for Tals or field Bunds.

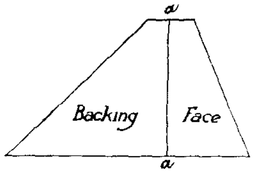
The best *tals* are those constructed of large boulders, built up with a batter of 1 in 4 on the downstream side, and backed with smaller stones, gradually reducing to the size of a hen's egg, having a surface slope of 1 to 1. The top width may be 1½ feet.



If large boulders (the size of a man's head or greater) are not available, smaller boulders may be used with batter of 1 in 3 (⅓ to 1) or even 1 in 2 (½ to 1). No high *tal* (over 5 feet), however, would be safe with small ones unless they were very carefully laid with a good thickness at the base.



In all cases it is best (though *not necessary with low bunds*) to build up the downstream face so that it will be just self-supporting as shown, in line '*a a*' being vertical at least.



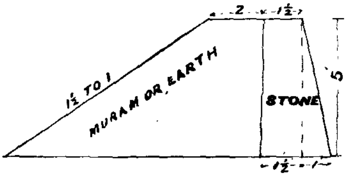
If no boulders are available the small stones only can be put up in the form of a bank with a slope of 1 to 1 on both sides and 2 feet top. But this form is less permanent.

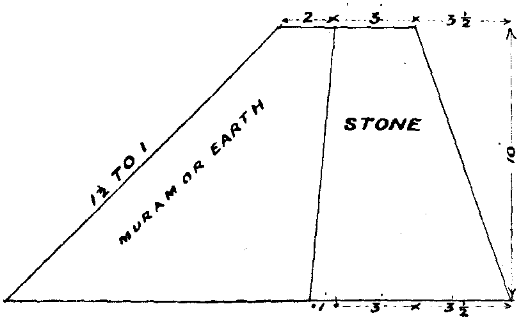
A table of quantities is attached giving the volume per foot run of *tals* for each foot in height and the quantities of face separate from backing.

A table of individual and through rates is also attached, assuming a lead of 500 feet. Other rates can be easily worked out.

When there is a scarcity of stones, earth and *murrum* can be used to replace part of the backing, but this is not to be recommended. The facing must always be made strong enough to withstand the earth pressure and be self-supporting also. For this purpose the top width of the face work should be from 1½ to 3 feet, and the bed width from ⅓ to ½ of the height, the greater proportions being adopted for high *tals* (over 5 feet).

The backing should have a 2 feet top and slope of 1½ to 1.

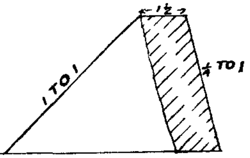




Rate per 100 c. ft.

	Up to— 5 feet	10 feet	15 feet
	Rs. A. P.	Rs. A. P.	Rs. A. P.
Facing	3 0 0	3 4 0	3 8 0
Earthwork . .	0 14 0	1 0 0	1 2 0

Design A.



Facework—

Uniform width 1½ feet.

Backing 1 to 1 and ¼ to 1.

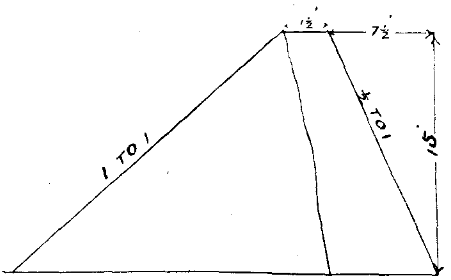
Depth	Area, Sq. feet. Face		Backing		Volume c. ft. per foot run	Cost per foot run		
	Each foot	Total area	Width at each foot	Total area		Face	Backing	Total
Feet	sq. ft.	sq. ft.		sq. ft.		Rs. a. p.	Rs. a. p.	Rs. a. p.
1	1·5	1·5	1·25	0·6	2·1	0 0 9	0 0 2	0 0 11
2	1·5	3·0	2·5	2·5	5·5	0 1 5	0 0 7	0 2 0
3	1·5	4.5	3·75	5·6	10·1	0 2 2	0 1 4	0 3 6
4	1·5	6·0	5·0	10·0	16·0	0 2 11	0 2 5	0 5 4
5	1·5	7·5	6·25	15·6	23·1	0 3 7	0 3 9	0 7 4
6	1·5	9·0	7·5	22·5	31·5	0 4 8	0 5 10	0 10 6
7	1·5	10·5	8·75	30·6	41·1	0 5 4	0 7 11	0 13 3
8	1·5	12·0	10·0	40·0	52·0	0 6 1	0 10 3	1 0 4
9	1·5	13·5	11·25	50·6	64·1	0 6 10	0 13 0	1 3 10
10	1·5	15·0	12·5	62·5	77·5	0 7 6	0 15 11	1 7 5
11	1·5	16·5	13·75	75·6	92·1	0 8 10	1 4 8	1 13 6
12	1·5	18·0	15·0	90·0	108·0	0 9 6	1 8 7	2 2 1
13	1·5	19·5	16·25	105·6	125·1	0 10 3	1 12 7	2 6 10
14	1·5	21·0	17·50	122·5	143·5	0 11 0	2 1 2	2 12 2
15	1·5	22·5	18·75	140·6	163·1	0 11 8	2 5 9	3 1 5

Rates assumed, for lead of 500 feet—

	Rs. a. p.	c. ft.	Feet
Collecting, carrying and depositing small stones in backing	1 8 0	per 100 up to	5
	1 10 0	„ 100 „	10
	1 12 0	„ 100 „	15
Facework collecting and carrying 2-0-0 laying 1-0-0	3 0 0	„ 100 „	5
	3 4 0	„ 100 „	10
	8 0	„ 100 „	15

Design B.

Face ½ to 1 outside—
top 1½ feet.
1/10"1 overhang inside.
Backing 1 to 1 and
1/10 to 1.



Depth	Face: Width at each foot	Face: Each area	Face: Total area	Backing: Width at each foot	Backing: Each area	Backing: Total area	Volume Total c. ft. per foot run	Cost per foot run: Face	Cost per foot run: Backing	Cost per foot run: Total
Feet	Feet	sq. ft.	sq. ft.	Feet	sq. ft.	sq. ft.		Rs. A. P.	Rs. A. P.	Rs. A. P.
	1·5	..	..	0	..	..	..	..	..	..
1	1·9	1·7	1·7	1·1	..	0·5	2·2	0 0 9	0 0 1	0 0 10
2	2·3	2·1	3·8	2·2	..	2·2	6·0	0 1 8	0 0 6	0 2 2
3	2·7	2·5	6·3	3·3	..	5·0	11·3	0 2 9	0 1 2	0 2 11
4	3·1	2·9	9·2	4·4	..	8·8	18·0	0 4 1	0 2 1	0 6 2
5	3·5	3·3	12·5	5·5	..	13·7	26·2	0 5 6	0 3 3	0 8 9
6	3·9	3·7	16·2	6·6	..	19·8	36·0	0 7 9	0 5 1	0 12 10
7	4·3	4·1	20·3	7·7	..	27·0	47·3	0 9 7	0 6 11	1 0 6
8	4·7	4·5	24·8	8·8	..	35·2	60·0	0 11 8	0 9 0	1 4 8
9	5·1	4·9	29·7	9·9	..	44·5	74·2	0 13 11	0 11 4	1 9 3
10	5·5	5·3	35·0	11·0	..	55·0	90·0	1 0 3	0 14 0	1 14 3
11	5·9	5·7	40·7	12·1	..	66·0	106·7	1 4 6	1 2 0	2 0 6
12	6·3	6·1	46·8	13·2	..	79·2	126·0	1 7 4	1 5 6	2 12 10
13	6·7	6·5	53·3	14·3	..	9[illegible]0	146·3	1 10 6	1 9 2	3 3 8
14	7·1	6·9	60·2	15·4	..	107·8	168·0	1 13 9	1 13 1	3 10 10
15	7·5	7·3	67·5	16·5	..	123·8	191·3	2 1 2	2 1 3	4 2 5

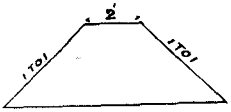
	Up to— 5 feet	10 feet	15 feet
	Rs. A. P.	Rs. A. P.	Rs. A. P.
Backing as before	1 8 0	1 10 0	1 12 0
Facework 4 as. less .	2 12 0	3 0 0	3 4 0

Design C.

Small stone bank—

Top 2 feet.

Slopes 1 to 1 each side.



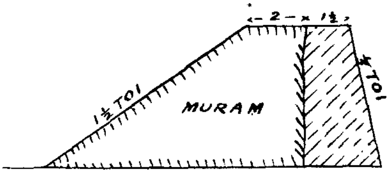
Depth	Width at each foot	Volume per foot run	Cost per foot run
Feet	Feet	C. feet	Rs. A. P.
..	2	..	....
1	4	3	0 0 9
2	6	8	0 1 11
3	8	15	0 3 7
4	10	24	0 5 9
5	12	35	0 8 5
6	14	48	0 12 5
7	16	63	1 0 3
8	18	80	1 4 6
9	20	99	1 9 3
10	22	120	1 14 6
11	24	143	2 7 0
12	26	168	2 13 8
13	28	195	3 4 8
14	30	224	3 12 3
15	32	255	4 4 4

Same as backing throughout—

Up to—		
5 feet.	10 feet.	15 feet.
Rs. A. P.	Rs. A. P.	Rs. A. P.
1 8 0	1 10 0	1 12 0

Design D.

Stone work—1½' top, batter 1/5 to 1 back vertical. } 0·5.
Earthwork—2' top, 1½ to 1 and vertical. }

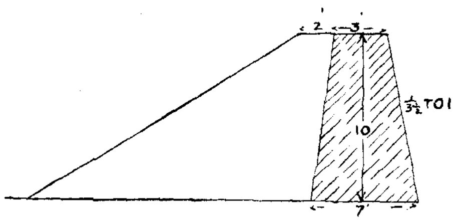


Depth	Rs. 3 Face			14 annas Backing			Total Volume per foot run	Cost per foot run		
	Width at each foot	Each area	Total area	Width at each foot	Each area	Total area		Face	Backing	Total
Feet	Feet	sq. ft.	sq. ft.	Feet	sq. ft.	sq. ft.	c. ft.	Rs. A. P.	Rs. A. P.	Rs. A. P.
..	1·5	..	..	2	..	..	..	..	..	..
1	1·7	1·6	1·6	3½	2·8	2·8	4·4	0 0 9	0 0 5	0 1 2
2	1·9	1·8	3·4	5	4·2	7·0	10·4	0 1 8	0 1 0	0 2 8
3	2·1	2·0	5·4	6½	5·8	12·8	18·2	0 2 7	0 1 9	0 4 4
4	2·3	2·2	7·6	8	7·2	20·0	27·6	0 3 8	0 2 10	0 6 6
5	2·5	2·4	10·0	9½	8·8	28·8	38·8	0 4 10	0 4 0	0 8 10

Design E.

Stonework—3′ top, batter 1/3½ to 1 back 1/10 to 1.

Earthwork—2′ top, 1½ to 1 and 1/10 to 1 overhang.



Depth	Rs. 3 Face			14 Annas Backing			Total Volume per foot run	Cost per foot run		
	Width at each foot	Each area	Total area	Width at each foot	Each area	Total area		Face	Backing	Total
Feet	Feet	sq. ft.	sq. ft.	Feet	sq. ft.	sq. ft.	c. ft.	Rs. A. P	Rs. A. P.	Rs. A. P.
..	3	..	..	2	..	..	..	..	..	..
1	3·45	3·2	3·2	3·4	2·7	2·7	5·9	0 1 6	0 0 5	0 1 11
2	3·90	3·7	6·9	4·8	4·1	6·8	13·7	0 3 4	0 0 11	0 4 3
3	4·35	4·1	11·0	6·2	5·5	12·3	23·3	0 5 3	0 1 9	0 7 0
4	4·80	4·6	15·6	7·6	6·9	19·2	34·8	0 7 6	0 2 8	0 10 2
5	5·25	5·0	20·6	9·0	8·3	27·5	48·1	0 9 11	0 3 10	0 13 9
		Rs. 3-4			Re. 1					
6	5·70	5·5	26·1	10·4	9·7	37·2	63·3	0 13 5	0 5 11	1 3 4
7	6·15	5.9	32·0	11·8	11·1	48·3	80.3	1 0 5	0 7 7	1 8 0
8	6·60	6·4	38·4	13·2	12·5	60·8	99·2	1 3 6	0 9 6	1 13 0
9	7·05	6·8	45·2	14·6	13·9	74·7	119·9	1 6 11	0 11 7	2 2 6
10	7·50	7·3	52·5	16·0	15·3	90·0	142·5	1 10 6	0 13 10	2 8 4

(6)

MADRAS.

(a)

(D. T. Chadwick, I.C.S., *Director of Agriculture, Madras.*)

Mr. Howard's note naturally refers chiefly to conditions in Bihar which I imagine differ very considerably from those in Madras. Here the most valuable land is as a rule the lowest—the rice land. The Presidency too, as a whole, is a low-lying tract. All our large rivers are dammed with extensive irrigational systems taking off therefrom; our smaller rivers and streams are either also dammed or divided into numerous branches to fill large reservoirs locally known as "Tanks." A very large number of these tanks are purely rainfed, *i.e.*, a *bund* is thrown across a natural depression and all the surplus drainage water from the higher lands is caught in the basin so formed. The surplus of water of one tank leads to another, and so on indefinitely. These tanks or reservoirs form one of the chief features of the south and east of the Madras Presidency. The result is that of all the rivers flowing to the east practically none except the Godaveri and Kistna ever reach the sea. The Cauvery, Kistna and Godaveri bring down considerable quantities of silt, especially during the South-West Monsoon, but for 9 to 10 months in the year their fertilizing waters are spread out over 2,722,423 acres of rice land. We are grateful for the washings of Mysore, Bombay and Hyderabad and would not view with equanimity any action which would effectively cut off our supplies of the so-called "red" water.

In regard to our smaller streams and rivers these also feed numerous channels and numberless tanks and only reach the sea for a very few days in the height of the monsoon. These tanks occur in many parts of the country every few miles and form most efficient silt traps. Silt can be carted by the ryots in the hot weather free of charge from these tanks. This is done to a considerable extent and the silt so gained is applied to the wet and garden lands, *i.e.*, to our most valuable fields. Our best fields are not thus robbed of their fine soil for the sake of less valuable ones; but throughout, the washings of other provinces and those from our worst fields go to maintain the fertility of our most valuable ones.

The application of the theory that each field should consume its own rain water would create the gravest difficulties in this Presidency. The supply of water to irrigational sources is governed partly by executive orders of Government, partly by custom, and partly by case made law. It is exceedingly dangerous to attempt to interfere with existing practice. In two districts of the Presidency, *viz.*, Chingleput and Ganjam, the pratice has existed for a long time of making *bunds* round the fields to impound rain water; and as a result disputes with cultivators under the lower tanks are common. Moreover, it is very doubtful whether the practice is economically sound. The rainfall in these districts is not very heavy, and the ryots by this practice render their fields unfit for cultivation with dry crops and are tempted to grow rice which not infrequently fails.

On the West Coast the land is naturally very hard and the fields are most carefully terraced.

The more valuable dry lands, *e.g.*, in black cotton soil tracts, most frequently have round them a *bund* of somewhat higher land left to grass, and where a wash threatens are at times revetted by the ryots. There are of course some careless farmers everywhere, but the majority take care of their black cotton soils.

From some of worst red soils wash does occur and is possibly increased by the privilege allowed to ryots to take up such lands for temporary cultivation in years of good rainfall. With such methods of cultivation much money cannot clearly be spent by the ryots on permanent improvements and the disturbing of the surface due to ploughing, etc., may possibly increase the loss by wash. The chief hope for these would possibly lie in making many of them ultimately into properly managed grazing reserves.

Mr. Anstead will deal with the problem as it affects planting interests.

But in the permanently occupied portions of the Presidency, I do not think there is much scope for these methods and in some cases their adoption might easily be against the interests of the most valuable and most important land in the Presidency. Moreover, there are no estates in Madras as in Bihar, and the introduction of a widespread system of bunding presents considerable difficulties in a country of small and scattered holdings.

Drainage. Undoubtedly, if it were possible to reconstruct entirely the irrigational systems of Tanjore, Kistna and Godaveri, the canals and channels would be aligned differently and more provision made for drainage, but when anything from Rs. 1,000 to Rs. 2,000 an acre and over has to be paid to acquire land, there is a very practical limit to the purchase of land for the construction of drains. Mr. Harrison's work would go to show that the optimum rate of drainage for rice is a very slow one, and under most of our tanks sub-soil drainage does occur. In a few localities underground drainage to remove alkalinity is sometimes possible and work on this has been started with some promise of success (*vide* Mr. Wood's article on sub-soil drainage in paddy lands in the Agricultural Journal of India, vol. IX, pt. 3, 1914). But this is a different question from Mr. Howard's.

Conservation of soil moisture. Work is at present in progress on this—witness the introduction of the drill and harrow, etc., in the black cotton soil tract of Tinnevelly. Eight years ago these implements were entirely unknown there. Last year the ryots used their own implements on over 7,000 acres of their own land.

(b)

SOUTHERN INDIAN PLANTING DISTRICTS.

(R. D. ANSTEAD, B.A., *Deputy Director of Agriculture, Planting Districts.*)

In Bulletin No. 53 of 1915, issued by the Agricultural Research Institute, Pusa, Mr. Howard calls attention to the damage caused in India by soil erosion and quotes the hill tracts of the centre of Ceylon as an example where the agricultural capital of the land has been allowed to run waste.

Numerous examples of the same thing are to be found in the Planting Districts of Southern India cleared of forest for the purposes of planting tea and rubber. As Mr. Howard says "little or no provision was made at the time (of clearing) to retain *in situ* the fine soil of the original forest and, in consequence, the loss of soil has been enormous and is still going on." This process of loss is exaggerated by the pernicious system of 'clean weeding' which is adopted on many of the estates and insisted upon by the visiting agents and company managers from home. Throughout the year the soil is kept bare of vegetation, except the actual crop, and each month it is weeded and scraped with mamotties, and each monsoon the fine surface soil is washed away and lost. The amount of this loss is evidenced by the streams and rivers in estate districts during the monsoon which are yellow with the charge of soil, while cases have been known of legal proceedings being taken by the holders of paddy lands in the valleys below on account of the silting up of their fields.

Examples can be seen of the final results of this system of clean weeding on the Coorg-Mangalore ghaut where land which was at one time planted with tea and coffee has now been abandoned and in place of the original jungle is now covered with scrub and lantana.

The declining fertility of the ridges, the exposure of the surface roots of the tea at the top of steep slopes, and the number of bushes which have been thrown out of plucking on many estates all point the same way, and so serious is this problem of soil erosion, which the planters call 'wash,' becoming that the majority of estates are beginning to turn their attention seriously to its prevention, and are making attempts to restore the lost fertility of the soil by the addition of green dressings and manures, but even now insufficient attention is paid to the matter.

In the case of tea especially large sums of money are expended in labour and manure with the object of producing a good tilth in the surface soil, and the top eight or twelve inches of the soil are full of plant food and bacteria. When this is washed away the loss is enormous.

The remedy suggested by Mr. Howard is to terrace the land as soon as it is cleared. On some tea and rubber estates in South India this has been tried but the expense of the work is prohibitive over big areas. Various methods of cultivation can be adopted, however, which tend to produce natural terraces and reduce soil erosion to a minimum, and on a number of estates these methods have been adopted as a whole or in part with considerable success.

In the first place as soon as the land is cleared it is drained along the contours, the drains being traced in at proper distances and with the correct slope to ensure a gentle flow of water. At intervals pits are dug in these drains which catch the fine soil in very heavy rain and the pits are periodically cleaned out and the soil in them put back between the rows of tea. Along the upper sides of the drains a hedge of some leguminous plant like *Sophora glauca* can be planted with advantage. This keeps the bank of the drain and also checks the flow of the water on much the same principle as the turf on the sides of the surface drains at Pusa described by Mr. Howard. The hedge is kept low by periodically lopping it, the loppings being used to mulch the surrounding tea.

In place of mammotty weeding hand weeding is being extensively adopted, the weeds being removed with a minimum disturbance of the soil. On steep slopes, however, during the monsoon months, the weeds should undoubtedly be only grass knifed and their roots left in the soil to aid in holding it in place. The opposition of the clean weeding school to this practice is based on the assumption that the weeds are extracting plant food from the soil and thus robbing the tea. It would appear, however, that this does not much matter since the plant food in question is not being removed, and the weeds can safely be dug in in the dry weather when they would extract moisture needed by the tea from the top layer of soil and they then rot down and return the food they have extracted in an easily available form. The loss is thus merely a temporary one, the food elements being only locked up for a short time, while the loss caused by soil erosion is far more serious in that it is a total loss of organic matter, soil particles, bacteria, and nitrates.

The best practice of all, however, and one to which not enough attention is as yet paid in Southern Indian planting districts, is the use of cover crops of leguminous plants. These, if kept on the soil during the monsoon, reduce the amount of soil erosion very considerably by increasing the amount of water absorbed by the soil by retaining it on the surface for a longer time and thus giving it a better chance to soak in. The soil is, moreover, kept more or less open by the roots penetrating it and these roots form channels along which the water may be conducted to the sub-soil. Cover crops also afford protection to the soil by retarding the movement of the water flowing over the surface and preventing the removal of soil particles.

Many suitable plants for the purpose grow wild in the hills and are easily established as a cover crop. The seed may be collected and sown and the weeding coolies taught to leave the young plants. By means of such preferential weedings the desired plant can soon be established as a cover crop. Species of *Crotalaria*, *Cassia*, *Tephrosia*, and *Indigofera* are common and all are suitable green dressings not only aiding in the reduction of soil erosion but

themselves supplying large quantities of nitrogen and organic matter when finally incorporated with the soil by cutting them down and using them as a mulch or digging them into the soil at suitable times.

In this connection an experiment conducted in Ceylon and reported in the *Paradeniya Experiment Station Progress Report* of 19th March to 12th May 1910 is significant. In this experiment soil on a steep slope was treated in various different ways and the actual loss of soil caused by wash was measured. The results recorded were as follows :—

Soil treatment	Soil erosion in lbs.
1. Plain deep forking	1,393½
2. Blank (untreated)	814
3. Dadap scrumps (*Erythrina indica*)	330
4. *Crotalaria incana*	309
5. Mixed Crotalarias	176
6. Albizzia plants	168
7. Ipomœa	133
8. Crotalaria across the slope	50
9. *Desmodium triflorum*	30

This experiment shows very plainly the effect of cover crops. *Desmodium triflorum* is a close growing cover-like plant very common everywhere in Southern India and it has proved itself a most useful plant as a soil binder on very steep slopes.

If all cultivation methods are carried out along the contours of the slopes instead of up and down, then there is a tendency for natural terraces to be formed which prevent erosion. Thus steep land may be weeded along the contours, and dug along the contours; the pluckers may be sent along the lines of the contours instead of up and down the slopes. Again, if the tea prunings are buried, which is a very general practice, the trenches to receive them may be opened in alternate lines along the contours and the prunings placed in them with the top layer arranged so that the brush-wood is uppermost with some two inches left projecting from the surface. The pluckers work along the other row and the soil pushed down the slope and washed down the slope by surface water is caught by the projecting brush-wood and largely retained.

When a combination of the methods outlined above is adopted natural terraces are gradually formed and soil erosion reduced to a minimum in a practical way.

Another form of soil erosion occurs in a few tea districts of Southern India, such for instance as the Travancore Hills. Here the land is very steep and the soil is of such a loose texture that in the dry weather it is apt to exceed the angle of repose and at the least touch to come sliding down. Wind even sets it moving, and the plucking coolies passing through the fields send the soil sliding down the slopes on to the roads. The loss of surface soil in such places is enormous and very rapid and the ridges are already denuded of surface soil. This is known locally as ' dry wash ' and the methods of its control depend largely on keeping a cover crop on the ground throughout the year.

I am in entire agreement with Mr. Howard as regards Planting Districts also when he says there is " no doubt that the natural agricultural capital of the country, the soil, is slowly running to waste " and that "the first condition of improving crop production is to take steps to stop this constant erosion and to keep the cultivated soil in its place." The annual loss caused to estates where the monsoon rainfall sometimes reaches 40 and 50 inches in a single month must be enormous and sufficient attention is not paid to this loss by the general planting community.

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(7)

CENTRAL PROVINCES.

(R. G. Allan, M.A., *Principal, Agricultural College, Nagpur.*)

Erosion, Drainage and Water Conservation.

In this note I may state that I am indebted for district information, and with regard to the principal factors which prevent or at any rate reduce the active interest of the cultivator and landowner in such improvement, to Mr. Dyer, Settlement Officer, Nagpur, with whom I happen to have discussed the question.

In any note of this kind it is necessary to point out that it is impossible to be dogmatic in as heterogeneous a district as this one. There are 3 distinct geological formations, the trap, the gneisses and the sandstones (of the Kamthi type). There are three fairly well-defined types of cropping, cotton-juari, wheat-linseed, and paddy (the majority of which, however, lies outside my particular circle). The rainfall increases materially as one passes from north-west to south-east. The density of population varies from 400 per square mile in parts of Katol to 50 in parts of Umrer. The races and castes forming the population are very different from place to place.

Erosion. The amount of Soil Movement.

In a country of heavy torrential rains this is bound to be considerable, specially when we add to this the factor of undulation and irregularity and the factor of a deep clay loam soil. The following facts on the College Farm will illustrate the cutting effect, *i.e.*, the formation of *nullahs*, and the general gradual drifting effect even where the surface flow of water is not particularly marked.

In 1878, a drain with a depth of some 2½ feet at centre and 5 feet width was made to drain the old Model Farm portion of the present College Farm. At the present day the depth of the existing *nullah* varies from 7 to 11½ feet below present ground level, while the width before it was taken in hand and straightened some 4 to 5 years ago varied from 35 feet to 270 feet. Another water channel on the farm made some 3 years ago with a depth of 2 feet has now near its junction to the main channel, where it happens not to have been looked after, a depth of 5¼ feet for over 18 years.

As an example of slow drifting of soil, in 1908 I made a bund, the earth for which was 19,246 cubic feet dug from the field above the constructed bund. At the present day the whole of this earth has been replaced and the level of the field above the bund has risen some ¾ feet above the level of the field below the bund, though before bunding both, at this point, were at approximately the same level. The large quantity of earth has been gathered from a drainage area of one field of some 8 acres, with an average slope of about 1 in 200. These will suffice to illustrate the marked soil loss which may proceed on black soil of fair depth under the influence of an average downfall of 5 inches a week between the 1st of July and 15th of August when the heaviest downpours take place.

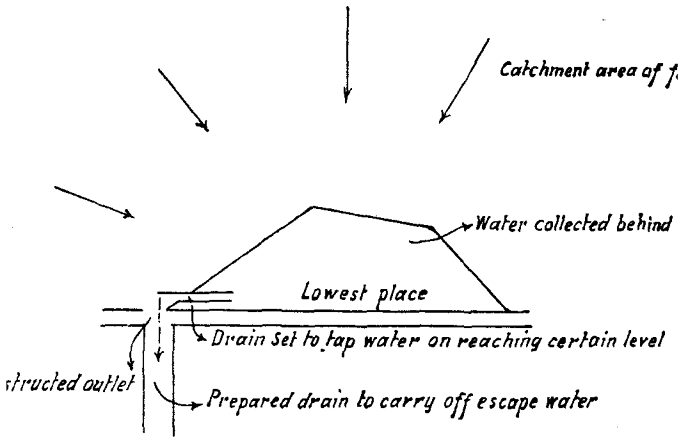
Steps effective to prevent Erosion.

The steps necessary to prevent or lessen the action are terracing, bunding, cross drainage to prevent the flow of water from other fields, and deeper cultivation at right angles to the slope. Under-drainage is, of course, extremely

efficient, specially if accompanied by cultivation ; but can scarcely be said to be beyond the strictly experimental stage. The growth of a thick ground vegetation like grass and belts of trees are also preventatives. I have employed all the first five of the above and have noted effects of the sixth though I have not actually planted grasses for this purpose.

Terracing and Breaks.

Terracing and bunding, as I mean it, *i.e.*, as a method of preventing the surface flow of water, are in reality somewhat similar in effect though slightly differently arrived at in practice and final appearance, the former being the more *pucca* agricultural work. It assumes a series of steps and is arrived at partly by earth movement and levelling, and partly by the natural levelling action of water. The latter is simply a break behind which earth is deposited so that in course of time, if the break is sufficiently *pucca* and sufficiently high, the area will level up. It is usual across a hollow on sloping land, across an incipient *nullah* or at the lower end or corner of a sloping field. The material used for the break will vary. If taken in hand at an early stage, *tur* or *sann* stalks roughly woven between upright verticals of bamboo will have the desired effect, specially if put fairly frequently in the course of a waterway. Otherwise breaks of stone, if of not too large a size, or earth can be used. Where a really big depression has to be checked and the water flow is considerable an earth bund is necessary. Their chief structural defects are lack of sufficient width at the base, resulting in disastrous breaches, and that they form spots where *kans* and *kunda* will almost invariably develop. A bund of this type is benefited by having a suitable outlet,



or by inserting a wooden sluice into the bund at some height above the lowest point the sluice being closed during a fall and opened after if the water has risen to its level, allowing the excess water to be drawn off, having left the mud behind it in the lower area. This is applicable when the bund is near the edge of a *nullah* on the field margin or is connected with some definite water channel or open drain of constructed character. The existence of the escape prevents undue pressure on the bund and an undue collection of water behind it (which may tend to delay even *rabi* sowing), and allows of a *kharif* field being bunded against erosion. In the case of bunds of stones these, to be effective, must not be of large boulders, and should be placed at fairly frequent intervals. Their effect is to check the movement of the soil, holding the water current sufficiently to permit of deposit but yet allowing the water to get along sufficiently quickly to prevent of a standing crop on the land being badly water-logged. Terracing is found on slightly sloping rice land where an absolutely flat bed is necessary, and is arrived at by the cross earth or contour bunds. The object here is not, however, preventing direct erosion. Terracing for this latter purpose is not infrequently arrived at by stone or boulder bunds built across the slope, the earth above these being assisted by cultivation, scraping and water flow to level up the soil.

In the Nagpur District terracing and bunding is found chiefly in the Katol and Saoner tracts. There are several reasons for this, the country is trap and the soil thin and boulders are easily procured, hence stone for dykes is always at hand. Terracing is almost essential to get anything of a crop. The cultivators are energetic and the pressure of population necessitates a more intensive form of cultivation. Dykes vary from walls with 6 to 8 feet drop on the lower side to small stone bunds across incipient *nullahs*. In the *rabi* area in Umrer such work is neglected. The conditions are different. The soil is deep, stones few and the assessment even for good wheat land *only 12 annas per acre. The cultivator gets along with only a very poor cultivation and in consequence with only* a shallow extensive cultivation improvement works are neglected.

Surface Drainage.

This is the control of the surface water. This is divisible into two sections : (1) the removal of excess water from a field thus preventing water-logging in a growing crop ; (2) the prevention of the in-flow of water from higher fields and the direction of the water of either of the above down legitimate channels. The latter of these with the control of the direction of the flow of the water are both directed to the prevention of erosion, while the former may be dealt with under drainage. In the first place, it is in the majority of cases safe to assume that the soil will not naturally absorb all the heavy precipitation of the early part of the monsoon and that this water must find its way to a lower level. A big earth bund is only part of the work—it prevents the onward rush of the water, but, even if the area on which the water collects behind the bund eventually absorbs the water and allows of *rabi* cultivation, a fair percentage of this cannot be at its best for sowing *rabi* in October. Its highest efficiency is reached when it

allows of the precipitation of mud, but is provided with a means of getting rid of all water which the soil cannot comfortably absorb by October 15, as I have outlined under bunding.

Unless a field is very large the erosion done by the water which falls directly on it is controllable. Much the worst damage and scouring is done by water gathered on a succession of fields on a slope, gathering velocity and volume as it passes from one to the next. Cross ditches leading to a main water channel down the slop reduces the ravages of the water. As a rule these are not difficult or expensive compared with the beneficial effect they produce. This cutting off of free water not only saves the surface soil but reduces water-logging, a factor which is marked in lowering *kharif* production. Accompanying cross drains, and even in their absence, the lack of control and direction of the water flowing down rain-formed field *nullahs* is accountable for a loss both of cropping area and productivity of the crop growing. I accept the fact that water must flow. If, however, its direction is straight in a prepared channel a very large saving of otherwise waste land results. There are two examples on the farm where at very small cost, areas of land have directly added to the crop bearing area. In this district one does find occasionally ditches set to cut off the in-flow from higher fields and ditches at the side of a field to lead off excess moisture. But they are few. In Mr. Dyer's opinion a great deal of this prevention of in-flow and direction of water could be done to improve the better class of field for *kharif* cultivation, excessive moisture being one of the most frequent sources of damage to both cotton and juari. In many cases a little direction in the flow of existing field *nullahs* would materially reduce the area so affected. Such works are however, he says, rare, partly because of the tendency to treat water-logging as the gift of God, and partly because the portions affected by the excessive water can be left to produce a second grade crop of linseed or wheat. It may be noted here, however, that in a sense the scrupulous drainage necessary in England is not so in India where a lower lying area can be expected to produce a *rabi* crop.

Deeper cultivation.

In my experience fields ploughed across the slope of the land are much less subject to gradual erosion and soil oss than those of like nature which are *bakhared*. The largest amount of soil moving takes place at the very beginning of the monsoon. The rain water is not able at once to penetrate the hard soil below the *bakhared* layer, probably due to the amount of air enclosed in the upper dry 10 to 12 inches of soil. If the first falls are excessive a *bakhared* field will show moving water within a few hours, a ploughed one a free absorbing surface. Later in the monsoon heavy showers, provided they are not continuous, are fairly easily absorbed by both. Again, if the monsoon begins by a series of short showers penetration of the dry upper layer is better and erosion and soil washing is less.

Deep cultivation because of its capacity to hold up a large body of water in the upper soil in the early part of the monsoon is apt to be harmful to cotton, in particular under Nagpur rain conditions, unless the field has a free natural drainage. For this reason, as a means of preventing or reducing erosion on these fields, it can only be applied to fields fairly well up the slope where water-logging is less likely. As a means of prevention on *rabi* soils it is effective.

Cultivation for this purpose is not practised. Most of the cultivation of soil is very shallow and, from reasons outlined under terracing and bunding, worse in the *rabi* area than elsewhere.

The effect of Grass.

I have never used grass strips as preventatives. I fancy that they would act if made before damage had begun, but not otherwise. The force of water down a once-formed *nullah* would scarcely be checked sufficiently by the grass e ɔ lent in June and July to cause much deposit of silt. In one series where two plots have lain fallow, one with its grass cut for hay and the other wild, there is a slighter elevation of soil on these plots, specially the latter, showing that, whether the plot has acted as water-catch or not, the vegetation growth has prevented its losing the amount of soil lost by those about it by almost imperceptible water movement.

Drainage. Surface Drainage.

The removal of excess water, either direct fall on the field or received from outside its limits.

I have dealt with this under erosion and need not enlarge on it. I am in agreement with the principle that each field should, as far as possible, be responsible for its own water and that the annual precipitation on any one field is as much as it requires for the production of a crop in this district. The amount of removal of this directly received water (*i.e.*, rain received on the field) which it is desirable to effect will depend on the crop. Except in the case mentioned later, I do not consider that the removal of water in a field, which is to grow a *rabi* crop, is desirable though occasionally a hollow in a field may be a source of trouble in preparation after the monsoon is over, either causing delay or the cultivation of the hollow before it is fit, producing an unsatisfactory tilth. The damage arises not so much from water-logging as from too early tillage for the amount of moisture contained. In *rabi* fields on the black soil I believe in the maximum absorption of directly received water possible and even, with the exception of the case cited below, the addition of extra water from other fields, provided this is not arrived at by serious erosion. In *kharif* fields, on the other hand, the water directly received is often in excess of requirement and should be disposed of, if possible. The best results at a simple surface drainage have been got by ploughing the soil in lands of different widths and using the open furrow as a drain, its direction with regard to the fall of the land varying with the amount of the fall. On flat or nearly flat fields this may take the direction of the slope of the land, or if land slopes the open furrow may be practically across the slope. I have also attempted running furrows made by a double mould plough at intervals either in the direction of the crop or through it if sown in the direction of the slope but am not in position to state effects.

Under Drainages.

This is probably well in advance of the agricultural prac ice of India for some time t come. The effects of tile drains have, however, been extraordinary. There are now some 3 or 4 small systems on the farm and in each case the effect has been most satisfactory. In the sewage area the plot under *juar* was able to dispose of the water of the monsoon together with the sewage water applied, to continue growing steadily and stand 8 to 9 feet high yielding 14,200 lbs. per acre on the sewage supplied plot and 12,200 lbs. on the plot without sewage, whereas in the similar crop on undrained land the height of the plants varied from 5 or 6 feet to 2 feet and less according as to whether they stood at the upper or lower end of the plot and gave about 8,000 lbs. per acre. In cane the crop was on the average 14 to 20 inches higher than on the undrained block and stood the sewage effluent (largely aqueous in character) easily.

On another block a low-lying area on an otherwise *kharif* field, on which drainage from upper levels had in the past practically assured an entire failure of anything like cotton, *juar* or *tur* and which, because of its out of the way position, rarely received tillage for *rabi* crops at the best time. The effect of the introduction of pipes was marked. In the first year a cotton crop of some 430 lbs. per acre was got as against a little over 300 on the rest of the field, the crop remained green and continued growth in July and early August, while that on the larger part of the same field stood still. The result was that the second picking on this plot coincided with the first on the rest of the field and three good pickings were got as against two. In the second year *juar* was grown for silage purposes, fairly closely, a fresh area of drains having been added. The effect was again most marked. The underdrained area carried a uniform crop of fodder standing about 7 feet to 8 feet high and practically clear of weeds due to the

rapid growth of the *juar* in its early stages. The low-lying area above this block, undrained and treated to similar cultivation, bore a crop in which *sheora* (Alisocarpus) predominated. At the time of siloing, the drained area had set seed thoroughly and was as advanced as the crop on the true *kharif* section of the field, whereas that on the less *kharif* portion had not flowered. The yield was at the rate of about 10 tons green food per acre. On lifting some of the drains for inspection this year little or no silting was visible. The soil is a clay loam, the pipes are set about 2 feet 9 inches to 2 feet 6 inches in depth 27 feet apart. A gravel layer is applied after laying the pipe. The cost is about Rs. 75 to 78 per acre and will probably be less after further experiment. The outturns on the two years, if compared with the product from the area before drainage or with the part still undrained, has more than paid for its cost in two years. I have no suggestion to make as to its introduction. It is, of course, undesirable in *rabi* land and the crops grown would have to be of remunerative character. I fancy, however, that in irrigated garden crops and cane on heavier soils it might very easily be a satisfactory investment.

Conservation of Soil Moisture.

By Tillage.

Kharif crops.

Ploughing, unless for *kans* or *kunda* and unless the land is naturally drained, is of doubtful value with the local rainfall and the type of cotton grown. Hot weather ploughing is usually costly, it delays the sowing and increases the surface-held water. Both of these are harmful to the cotton plant. In the two experimental series where this is done the value returned frequently does not pay the cost and the crop is often actually worse. Inter-cultivation is, however, of distinct value from this aspect, though to have an effectively fine mulch after the rains requires working during the monsoon and timely effort at its close. The early ripening of the local cotton does not show a demand for inter-cultivation over that given in good Berar practice.

Rabi crops.

In these every effort to ensure this is essential. I cannot say that I have found hot-weather cultivation in normal years on the black soil gives results equal with the cost and I am inclined to believe that ploughing at the break of the monsoon and again in August is likely to give more or as satisfactory results for *rabi* crops. The last ploughing enables the soil to pick up the last part of the monsoon, while if done by the 15th of August or so there is generally enough precipitation to allow of sufficient consolidation without recourse to pressure. This practice is still in the experimental stage. On the other hand, ploughing instead of *bakharing*, as the initial form of cultivation in the monsoon, followed by *bakharing* in both cases in the monsoon and after has definitely proved itself of advantage. After 15 years of experiment it may be interesting, however, to note that the deeper form of cultivation appears to be having a more exhaustive effect. The average returns during the last five years are not much better than those of the *bakhared* plots, indicating that regular deeper cultivation though producing bigger returns to begin with makes a bigger call on the available plant food and requires some manurial return. Experiments in the quality of the tillage apart from depth indicate the value of finer mulch (3 to 3½ inches in depth) at the end of the monsoon than is the usual best local practice. One of the most marked experiments is one in which land is *bakhared* in the hot weather, left entirely alone in the monsoon and at its close *bakhared* to produce a surface mulch under which *rabi* sowing is usually made. In spite of the fact that though the weed growth, though evident, is not particularly luxuriant, the return given by the plot is ludicrously small and much below even the double cropped plots of the same series. Experiments have also been made in seed rate and in the spacing of the rows, the wider rowed plots being inter-cultivated after winter rains. The results are quoted and indicate some advantage in a lower seed rate and a wider line than is usually common. The conservation of moisture and the best use of the water stored are thereby affected.

Local tillage.

The efforts to retain or conserve moisture in this district are, for the most part, distinctly backward both for *kharif* and *rabi* crops and are much below those found in Berar. Deep cultivation is almost unknown, the only form tending to it is the after effect of a groundnut crop, the harvesting of which has caused the land to be opened up to a greater depth than the usual *bakharing* affects. Hot weather cultivation even for *kharif* crops is frequently neglected. Inter-cultivation for cotton is almost unknown except as incidental to weeding, and that is much more carelessly done than in Berar. A filthy cotton field is quite common in Nagpur, while in the wheat areas the average preparatory tillage is poor. I should say on the whole that the value of the tillage in the conservation of moisture is not realized, or if realized is not acted on.

Conservation by the retention of water by earth bunds.

Beyond the erection of bunds across hollows or sloping fields to check erosion and noting the effects of the accumulation of water behind these and the effect on the following *rabi* crop, I have not directly applied this method of making good the monsoon rainfall. In the Nagpur District there are two types of this :—

(*a*) The building of earth embankments round an ordinary field so as to prevent the escape of the water. This is not an important method, but is found to some extent in the *rabi* lands in eastern Umrer.

(*b*) The more important is auxiliary to rice cultivation. The *bori* or small tank used for rice irrigation is used for *rabi* when the water subsides. This is similar to the practice of throwing an earth bund across a hollow, noted earlier. The water held by the *bori* bund and not required for rice is thus conserved for the *rabi* crop. The practice is, however, not universal. Many *boris* are not sown. Others are sown as they dry up something like the *galabanding* in the north of the Central Provinces, the upper portion carrying a strip of linseed followed by one of wheat and one of gram as we pass towards the bund. In the neighbourhood of the bund there is usually a quagmire occupying perhaps one-fourth—one-third of the whole area. It is in this respect that drainage, mentioned in connection with erosion and under surface drainage, would come in useful. The common defect recorded in the case of this *bori* cultivation arises from bunding without adequate arrangement to draw off superfluous water in time to permit of sowing a winter crop. If, after rice irrigation was complete, the water, not needed, could be allowed to escape, a larger area of fertile land, well-stocked with moisture, would become available. The finest *rabi* crops in the district are found in these *boris*.

The possibility of improvement in the District.

I have outlined my observations on the three sections of the note and recorded local agricultural practice in relation to these. I must now turn to the considerations of the chances of general improvement of land erosion, drainage and soil conservation in the future, as up to date there is not much evidence of their receiving anything but isolate attention.

(1) A man is energetic in proportion as he is compelled to be. The cultivation is best and the attempts at field protection most in evidence where the rainfall is lower, the pressure of population greater and the assessment and rents of land higher. In a fair proportion of the district these incentives do not exist or are less in evidence, and in such tracts cultivation is extensive and careless, the cultivator being content with low returns per acre as sufficient for his needs.

(2) The district is under a revenue system which tends to slackness. Landlords are of two classes— small men, little better than cultivators, and absentees, the larger majority of whom are rent receivers and money-lenders. Landlord improvements are unknown. Cultivators improvements are few. In this, however, it should be noted,

that it would be very difficult for a landlord, who felt inclined to do so, to act, if, as would probably be the case, an improvement scheme affected the holding of several tenants in different rights, to say nothing of the possible effect of a patch of *malik-makbuza* land in the middle of the area.

(3) The protection of tenants has many advantages; but as long as he pays the rent the landlord cannot force any standard of cultivation. The protection of the tenant, coupled with a modified system of succession, is against improvements by tenants unless made energetic by the causes in the first section.

In the distant future co-operation may allow of schemes which are impossible with many and sub-divided rights to contend with.

(4) The indebtedness of the tenant except in a few villages has little to do with the problem. I mean that indebtedness as a factor against incentive to make effort, as noted by Mr. Keatinge in the Rural Economy of the Deccan. Most debts are productive, *i.e.*, for wells, purchase of cattle and land. Though in this connection I may note the effect of one point, the tendency to adopt, a system in which most of the rent for fields, newly taken up, is capitalised and paid in advance. The cultivator instead of paying a moderate sum each year and thus possessing some working capital, spends all his capital and something more in the first instance, paying later a very small annual rent, but entering on his holding rich in the factor land but wanting in another, *i.e.*, capital goods. This militates against improvement.

(5) The practice of sub-letting induced by the big margin between rents and the assessed value of the fields does not tend to improvements of a permanent type.

Generally speaking, any wide scheme of land improvement specially with regard to field erosion and drainage is scarcely likely to be a feature of agricultural improvement in this generation. Information acquired now may be applied in isolated holdings over the district but will only be of general application when economic conditions force a higher standard of agriculture.

Experiment I.

—	Ploughed in hot weather		*Bakhared* in hot weather	
	Grain	Straw	Grain	Straw
1st year	671	1,099	809	1,219
Average of next 4 years	581	685	529	534

Each of the last four years there has been a slight advantage in favour of the ploughed plot; but not that which might have been expected and not proportional to the high cost of the work. The first year is not included as in this case, as is apparent in practically every case in which black soil is first ploughed, the yield is worse.

Experiment II.

Average	*Ploughed* monsoon plough, depth 6"	*Ploughed* country plough, depth 4"·5"	*Bakhared*, depth 3"·4"	
	Grain	Grain	Grain	
1st years	699	635	573	per acre.
2nd 5 years	620	599	533	,,
3rd 5 years	584	562	505	,,

Difference, 1st and 3rd period	115	73	68 lb
Advantage of ploughed over *bakhared*	in 1st period ...		126 lb
	in 3rd period ...		79 lb

Ploughing has given a clear profit, though reduced, if continued practice, without manure. Except for first cultivation as above done at the break of the monsoon cultivation has been the same in all plots.

Experiment III.

—	Ordinary good *bakhar* cultivation	Frequent cultivation, not one ploughing	Ploughed in May and again in mid August and with similar cultivation to 2
	Grain	Grain	Grain
1st year	727	619	630
Average of next 3 years	704	783	977

The second plot receives about 2 more cultivations than one and is finished with a harrow.

In the third plot one of the *bakharings* in August is replaced by the plough—a good finish given at the close as in 2.

The effect of a second opening of the soil to get the latter monsoon is remarkable.

Experiment IV.

The effects of inter-culture and spacing on *rabi* crops.

Average outturn of four years.

Treatment	Grain, lb. per acre	Straw, lb. per acre
1. Sown in lines 12 inches apart, seed rate 80 lb	672	753
2. Sown in lines 18 inches apart, seed rate 80 lb	803	862
3. Sown in lines 12 inches apart, seed rate 40 lb	782	844
4. Sown in lines 18 inches apart, seed rate 40 lb	841	906

Plots 2 and 4 receive, in addition to the presowing cultivation common to all, one or two inter-cultivations in the growing season after falls of winter rain. The cost of these would vary from 6 to 12 annas per acre per annum. The crops on plots 2 and 4 ripen from 10 to 14 days later. The first plot roughly represents good local practice.

Letter No. 2275, dated the 20th July 1914, from Mr. John H. Ritchie, M.A., B.Sc., Deputy Director of Agriculture, Northern Circle, Jubbulpore, Central Provinces, to the Director of Agriculture and Industries, Central Provinces, Nagpur.

In reply to your No. 2027, dated the 16th July 1914, on the subject of soil denudation, drainage and conservation of soil moisture, I have the honour to give the following opinion :—

The solution of the problem of the excessive loss through rain wash in India depends to a great extent on the other two factors of drainage and method for the conservation of soil moisture. Mr. Howard asserts that this denudation of soil particles is found not only on steep hill-sides but on comparatively level ground. A certain amount of deposition of fine silt will always take place from high to low ground ; and the problem resolves itself into minimising this as far as possible. There are two solutions to this problem : (1) Proper and effective underground drainage, whether natural or artificial, would prevent a rush of water over the surface of the land and would keep the fine soil particles *in situ*. This underground drainage depends to a great extent on the state of the surface soil, whether it is free or open so as to allow the rain to enter the soil and so pass through quickly to the drains, or whether with the first fall of rain it is consolidated and so prevents the water entering the soil and consequently has to take the easiest way to obey the natural law of gravity, carrying with it the fine silt of the soil. If, therefore, it were possible to keep the surface of the soil always in an open condition, most of the rain would enter the soil, and the excess would pass out through the drainage instead of flowing over the surface.

(2) A second solution would be the construction of bunds as in Jubbulpore. The fields would soon level themselves unless on a steep slope ; but in order to do this, underground drainage is essential to carry off the excess moisture, for the system of emptying one field into another can give us no remedy. Underground drainage is, therefore, essential in this case also.

For deforested hill slopes, the best system and the cheapest one, in my opinion, would be to leave fairly wide strips of trees and grass at intervals round the hill. They would catch the fine silt and thus would be formed natural terraces down the hill-side. These strips would act quite as effectively, if not more so, as bunds, and their cost would be practically *nil*.

With regard to drainage. There is no doubt that the value and efficiency of all other methods in agriculture depend on drainage. All land must be drained either naturally or artificially to get the full value out of it. There are several reasons why land should be drained, and the two which seem to be most important in this country are—

(1) To get the excess of water out of the soil.

(2) To get water into the soil.

As far as I have seen, the soils seem to have a very good natural system of drainage, and the only places where this could be carried out are in the low-lying rice fields. The depth of the soil in most parts of the Central Provinces prevents any water stagnating on the surface and it would take a much larger rainfall, that is experienced here, to get any water to reach the bed rock of the land. What could be done with profit would be to get more of the water into the land by proper cultivation and to keep that water there by timely and suitable mulching.

This brings us to the third head of "Conservation of soil moisture." Much could be done, especially in the *rabi* season, to prevent short crops by keeping the soil in a proper condition by repeated harrowing. If the surface soil were kept in a loose dry condition, no moisture would be lost by evaporation, and the roots of the plants would always have sufficient moisture to keep them alive. This, of course, is the principle of dry farming for which, in my opinion, there is great possibility in India.

(G. EVANS, M.A., *Deputy Director of Agriculture, Northern Circle.*)

These three processes are all intimately connected with each other and are of great importance for the successful prosecution of agriculture in the Northern Districts of the Central Provinces, where a four months' season of heavy rainfall varying from 35 to 70 inches is succeeded by a long spell of dry weather.

I will endeavour to describe briefly in this note what is actually being done on the Experimental Farms in working out practical methods to solve these problems and will also mention how far the needs of the situation are at present understood and are being tackled by the local cultivator.

Soil Denudation. The tract I am dealing with consists of the Nerbudda Valley, averaging 25 miles in width and consisting of a flat plain of deep alluvial black soil, through the middle of which flows the Nerbudda river fed by numerous short tributaries which run into it more or less at right angles and have a short and steep course from the neighbouring hills on either side.

The high and rocky ranges of the Satpuras and the Vindhyas bound the valley to the South and North and on the summits of these two ranges we have a series of undulating plateaux somewhat cut up by rivers in deep beds and across which scattered ranges of low hills occur. The average soils are not so good as in the Nerbudda Valley

and vary from a deep black alluvium to the thinnest red laterite soils so covered with boulders as to be almost unculturable and barely capable of producing a crop of small millets, *til* or *jagni* (*Guzotia abyssynica*) more than twice in five years. Under these conditions denudation tends to be excessive.

Many of the Satpura plateaux were within comparatively recent times (50 or 60 years) under jungle. No doubt it was mostly scrub jungle, but it nevertheless tended to minimize the danger of floods. On these same plateaux now there is hardly a tree of any description to be seen outside the village mango *tope*. As a consequence disastrous floods are fairly common and do an immense of damage. For instance, two of the characteristic Satpura rivers, *viz.*, the Wainganga and Pench, each varying from ¼ to ½ mile in the width of their beds, rose 80 feet in some 15 hours during the monsoon of 1913, flooding much good land in their valleys and in many cases ruining good fields by depositing deep banks of sand and gravel on the surface. Many other similar instances could be noted and the only remedies seems to be either the reafforestation of the hills in the upper reaches of these rivers which would be a difficult practical problem as most of the land is taken up for cultivation or in training the rivers themselves, a gigantic or almost impracticable proposition under existing circumstances.

That the damage resulting from soil denudation is well-known to the average cultivator is indisputable, and in many parts of my circle they have very little to learn in the way of practical remedies. So far as possible they put these remedies into practice but really large works necessitating a good deal of capital expenditure are, of course, usually beyond their means. The Lodhis of Jubbulpore and Narsinghpur are adepts at this work and understand very well the value of earthen embankments to stop erosion. One Lodhi of my acquaintance has recently constructed an elaborate embankment across a shallow *nullah*. An over-flow and sluice have been constructed so that after the flood water has been checked and the silt deposited, the excess can be rapidly run off and pressure on the embankment relieved. This cultivator had managed to raise Rs. 3,000 for this work and he estimated that it would be six or seven years before he began to obtain any return on the capital he had so invested.

Similar large works are to be seen in the Murwara Tahsil of Jubbulpore. Many of them are permanent works of great value, producing large crops year after year even in famine seasons and commanding large areas. Some of these *narbunds*, as they are called, are over one hundred acres in area. Large works of this description are, however, the exception rather than the rule.

Similarly in the hilly tracts great attention is paid to the prevention of soil denudation. Here curiously enough the Gonds, an aboriginal tribe who have only lately taken to cultivation and are in many ways a most unintellectual and backward race, are proving themselves singularly adept. Bunds partly constructed of stones gathered from their fields are thrown across every small *nullah* or depression and serve as traps for the soil, which is washed down from the bare hills above, with the result that these *nullahs* are now assuming the form of a series of small, terraced fields in which wheat can be grown. They are very clever also in training the *nullahs* and diverting water in times of excessive floods. As pressure of population on the land increases there is little doubt but that the cultivators in these parts will pay more and more attention to the prevention of loss from denudation.

A number of practical experiments have been carried out on the Powarkheda Farm (Hoshangabad) for the last eight years in the methods of embanking to prevent denudation. Part of the land on this Farm was inferior black soil which was suffering greatly from erosion and was becoming more and more cut up each year and therefore rapidly deteriorating in quality. Different forms of field embankments were constructed and the practical value of each kind has been noted from year to year. It is found, for instance, that embankments made out of black soil alone stand well for the first two years but afterwards always begin to crack and these cracks invariably form points of weakness. Bunds of this class usually give way if the monsoon sets in with a sharp burst of rain which floods the land before the cracks have had time to close up by the moisting and consequent expansion of the clay. For pronounced slopes it has been found that an earthen bund with a filter gap filled with large stones faced on the upper side with a lattice work of branches is the best and an overflow to one side is also provided to relieve excessive pressure on the land in times of really heavy flood.

These operations have proved successful. Large deposits of silt have taken place and fields which formerly could only grow gram can now grow wheat in alternate years and are rapidly levelling up.

On undulating or slightly sloping land different measures are taken. Where the tendency to form small *nullahs* is observed, a series of silt traps formed out of upright pieces of galvanized iron sheeting or bamboo matting are erected at short intervals along the depression. So long as the rainfall is not excessive these silt traps serve their purpose very well, but unfortunately when very heavy rain occurs (and it must be remembered that it is not infrequent for as much as 10 inches to fall in a night), these small contrivances are apt to be swept away together with any silt they may have collected. A grass border is as effectual in stopping erosion as anything I know and narrow strips two feet wide are left at intervals across the line of slopes. The cultivators of Chhindwara and Seoni districts know this very well and plant rows of Mbow grass (*Saccharum*) across their fields to prevent excessive washing.

Drainage. The necessity for drainage is not fully realized by the cultivators. Even in valuable crops like sugarcane, one frequently sees fields which have suffered severely from red rot, a disease which is largely encouraged by water-logging. Experiments are being carried out on the Government Farms with a view to ensure proper drainage by means of surface drains, but underground drainage is at present impracticable owing to the initial cost and comparatively low value of land in these parts.

Referring to the larger side of the drainage question there are certain large tracts of wheat land in which the whole area is embanked with low bunds intended inclusively to impound the monsoon rainfall.* For this purpose they are admirably designed but there is at present no adequate means of rapidly running off the water as sowing time approaches except by percolation from one field to another until a *nullah* or river bed is reached often 10 or more miles away.

This lack of rapid drainage does not permit of cultivation before sowing as the sowing period is comparatively short and as a result the soils are apt to crack early and premature drying sometimes occurs. The functions of the nitrifying bacteria may also be retarded (as suggested by Mr. Howard)† owing to the long period of flooding and lack of cultivation, as I have noticed that in many badly water-logged fields the young wheat crop for the first month is very yellow and pinched in appearance although it afterwards picks up and yields well.

An area of this class of embanked land has been acquired for experimental purposes and the necessity or otherwise for drainage will, I trust, be definitely solved. One fact remains which is this, that if drainage is found essential it will be a very costly and difficult business which can only be effected by complete co-operation amongst the individual cultivators because the various holdings are mixed up in a most intricate way and the open drains which will be necessary will have to be very carefully graded to the nearest outfall owing to the very flat nature of the country.

Conservation of soil moisture. The more intellectual cultivator realises the value of a good tilth and also of mulching. It is partly because he does so that the practice of sowing *kharif* crops in lines, which has been extensively demonstrated by the Department, is now spreading rapidly. Improvements in the bullock hoe, to render it a more useful implement for interculture, are also observable from time to time and this point is also receiving attention at the Experimental Farms. The value of a good tilth is fully appreciated, but the difficulty is that the cultivator is very much at the mercy of the weather. For black wheat land the cultivator will always plough deep at the beginning of the rains and will continue to harrow when breaks occur, until sowing time arrives. Unfortunately in some years continuous rain occurs throughout July and August and does not permit harrowing to be done.

Under such circumstances it is usually noted that the young wheat suffers badly from heat in the last two months of the year unless rain, which is unusual at that period, opportunely falls. This "burning out" of the young

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* This system was described in a note entitled "Rabi field embankments" in the *Agricultural Journal of India*, Vol. VIII, Part II, April, 1913.

† *Bulletin* No. 33, *Agricultural Research Institute, Pusa.*

wheat was particularly noticeable in 1914 and was due mainly, I think, to bad tilth caused by continuous rains of the 1914 monsoon which did not permit the cultivator to get on the land for long periods at a time. There has been a good deal written in the non-scientific press of this country about the need for introducing "Dry farming methods," but as will be seen from my remarks above, the cultivator as a rule appreciates the main principles involved up to a certain point, at any rate, but is not always able to put them into practice.

The harrowing of young wheat in order to conserve moisture by forming a soil mulch has so far met with no success, as owing to the short growing period of wheat in the Central Provinces, the young plants do not have time to develop tillers or recover from the shock of harrowing.

(D. Clouston, M.A., B.Sc., *Deputy Director of Agriculture, Southern Circle.*)

Soil Denudation.—The loss of good soil every year due to denudation in the Central Provinces and Berar is very great. The undulating nature of the land over most of the area, and the comparatively heavy rainfall, ranging from 30 to 60 inches in different districts spread over a short rainy season of some 3½ months, makes far excessive loss where bunding is not practised. Bunding to stop soil denudation is practised by a few of the most enterprising landholders especially in the cotton tract; the bunds are made of earth or stone and generally demarcate the boundary of the lower end of the field. At times contour bunds are constructed within the boundary of the field. In most villages, however, no attempt whatever is made to prevent erosion with the result that in the more undulating fields larger and larger *nullahs* are formed, which cut up the land very badly. The cultivator's objection to bunding is that the initial cost is considerable when stones are used: when earth only is used frequent repairs are necessary; otherwise the bund gets gradually washed away. Earth bunds are not really suitable for this purpose. To be sufficiently strong they have to be made wide; but a wide bund tends to hold up water instead of allowing it to percolate through and thereby causes water-logging.

(2) To check erosion a good deal of bunding has been done on the Akola, Sindewahi and Tharsa Experimental Farms. The area selected for the Tharsa Farm was very badly scoured and cut by shallow *nullahs* which after a heavy rainfall became formidable streams. These drained the fields of the finest particles of soil. Owing to the difficulty of procuring stone in the neighbourhood, I found it necessary to get some hundreds of loads of the refuse of the Lohardongri Manganese Mines sent to this Farm by rail—a distance of 6 miles. With these lumps of crude Manganese ore contour bunds about 2 feet × 2 feet, 50 yards apart and faced up with earth and grass to prevent excessive percolation were constructed, across the existing *nullahs*. All the fields subject to scouring were treated in this way and the field and farm boundaries were raised in places so as to prevent, as far as possible, water entering or flowing off the farm area. The farm being in a *rabi* tract this could be done without injuring standing crops. By adopting this system, followed up by deep cultivation in the hot weather, the whole Farm area has been levelled, and no appreciable loss is now suffered from erosion.

(3) The effects of erosion are most serious in the cotton and wheat tracts and less so in rice districts; but in probably no area can the damage done be seen more clearly than in forest lands being brought under cultivation. In such areas the *nullahs* become roaring torrents of muddy water which carries into the rivers leaf mould, cattle-dung and other rich organic matter.

(4) It is important that the rate at which water percolates through these bunds should be regulated. If allowed to pass through too fast, the fine soil in suspension does not get time to settle, and no silting takes place. If the bund is made altogether water-tight so much water accumulates that it flows over the top, or round the end of the bund.

(5) The question of soil denudation is an important one, but I do not think our Department is in a position, at the present time, to get any system of field terracing carried out by the cultivators. The advantages gained by preventing erosion are so obvious that organized demonstration is not necessary. If at some future date Government should decide on pushing this method of land improvement, the work should clearly be entrusted to the Revenue Authorities who might be authorised to give *takavi* loans for this purpose. The Agricultural Department could give advice if necessary.

(6) *Drainage.* Underground drainage is not a practical proposition in these Provinces. With the exception of small areas of soil known as "Choppan" where the sub-soil is an impervious clay, the difficulty we experience is not in getting rid of the surplus rainfall or a short rainy season but in storing it in the soil for the following dry season. Land is so cheap and plentiful in the Central Provinces that it is very much more economical to leave *choppan* areas for *rabi* or for grazing than to attempt to dry them by an expensive underground system of drainage.

(7) Surface drains are sometimes very useful. In Chhattisgarh with a rainfall of about 55" we found it impossible to grow *juar* successfully except on land drained in this way. Deep surface drains to carry off the water which accumulates in the trenches of cane fields serve a useful purpose both in reducing the risk of red rot and in removing water which would otherwise affect the growth of the crop.

(8) *Conservation of Soil Moisture.* In the cotton tract methods of conserving the moisture of the soil are already understood and practised by the people. Interculture with the *daura* and *dhundia* at short intervals not only helps to keep down weeds but keeps a fine mulch of loose dry soil round the roots of the growing cotton, *juar* and *tur* plants. As a further safeguard the cultivator of the cotton tract now grows an early maturing cotton, namely *jari*, which despite the vagaries of the rainfall flourishes in this part. On his lighter soils he grows early *juars* like *ramkel*. In the rice tract the need of conserving the moisture of the soil is not so obvious, except in areas cropped with *rabi*. In the wheat tract nothing is done at present in the way of interculture, but I believe the experiment is well worth a trial. The use of dry leaves as a mulch for cane in its early stages is already practised in some parts of these Provinces.

The "dirtiness" of the cultivation in the Central Provinces and Berar is a factor which more than any other accounts for the loss of soil moisture. Fields get overrun with shrubs and other obnoxious weeds which live on the soil's moisture at the expense of the crop. The use of heavy iron ploughs like the turnwrest, which are capable of deep cultivation and of killing out the most deeply rooted weeds, would go far to remove this defect.

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(8)

ASSAM.

Subject XI.—Soil Denudation, drainage and conservation of moisture. The denudation of soil by rain is not a sufficiently pronounced evil, so far as the plains districts of Assam are concerned, to demand any action. In the hill districts, of course, denudation of soil takes place on a huge scale, but there is so much waste land, and denudation of hill slopes under cultivation is so difficult to prevent that we can do almost nothing. The remedies for denudation are afforestation and terracing. Afforestation is the work of the Forest Department and it implies cessation of

cultivation. As to terracing of hill slopes with a view to cultivation, it is a practice common enough in the Khasi and Jaintia Hills and the Naga Hills, only when the object is the cultivation of wet rice. Terracing for any other cultivation will not pay. It is a very expensive operation, and to be successful there must be natural facilities for irrigation without which wet rice will not grow. There is a terracing experiment now in progress in the Khasi Hills, but the prospect of its success is very doubtful.

As to drainage, it is important only in dry cultivation. The cultivators are fully alive to the importance of draining away surplus water from the land which they do by digging trenches round the field and letting the waters drain out into the nearest channel which leads it out of the village. Sub-soil drains are unknown, even in the tea gardens.

It is a much more important problem in the plains of Assam to keep out flood water from the rice fields. It is the chief problem with the cultivators of the low-lying areas in Sylhet and to a great extent also in the Assam Valley —a problem the solution of which they will hail with delight. Much has been done by the Government in this direction in the Sibsagar District, where a fairly complete system of protective embankments has existed since the days of the Assam Rajas. Many of these embankments had fallen into disrepair and were restored by Government a few years ago on the recommendation of a Committee of which I had the honour to be a member. Similar action is needed in Sylhet, but in that district the land belongs to Zamindars, for the most part petty landlords, who are either apathetic in the matter or do not possess the means of protecting the land. In many cases the land belongs to more than one proprietor, in which case any such improvement is out of the question. What is needed is some law like the Drainage Act of Bengal under which Government can step in, execute the required improvement and recover the cost of it from the landlords.

Conservation of soil moisture does not concern us much. The discussion of the Board had reference only to tracts of scanty—or uncertain rainfall.

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(9)

BURMA.

(H. Clayton, I.C.S., *Director of Agriculture, Burma.*)

The subject of soil denudation in Burma has in the past received very little attention except in the case of the shifting cultivation on hill-sides cleared by axe and fire, known locally as "Taungya." It has been held in some quarters that the denudation of the slopes of hills by this method of cultivation tends to give the streams and rivers which flow from them a more torrential character, thus impairing both their value for floating purposes and also adversely affecting such irrigation systems as may exist along their course. Enquiries by the Agricultural Department have, however, shown that on most clearings of this character a vigorous undergrowth at once makes its appearance and that it is, speaking generally, to the inability of the clearer to cope with this growth that the regular abandonment of the clearings after one or two years is due. This is also the experience of the Forest Department, except in the case of the higher hills where the loss of the forest is liable to leave the hill-side permanently bare. The problem so far as this class of cultivation is concerned has been or is being adequately dealt with by the reservation of the higher hills as forest reserves.

With regard to areas under permanent cultivation the amount of soil denudation taking place in Burma is undoubtedly large. The subject was recently dealt with in the report on the source, supply and agricultural value of silt in Burma by Mr Warth, Agricultural Chemist, published in 1911. Mr Warth pointed out that the greatest erosion appeared to take place in mid-Burma, *i.e.*, practically in the dry zone. The Deputy Commissioner, Myingyan, remarks that much of the white soils which predominate on the north and east of that district and which comprise the uplands, slopes and valleys among the steeper hills is due to denudation, the former covering of red soil having found its way to the lower levels.

The Deputy Commissioner, Sagaing, makes a somewhat similar statement with regard to conditions in his district also, and the denudation is, as a matter of fact, obvious throughout the dry zone to any but the most casual observer.

Terracing is a very common practice on lands used for dry crop cultivation throughout mid-Burma, but it appears to be confined to the heavier and darker soils. I do not remember in my experience ever having seen it on the sandy soils suitable for groundnut cultivation, though the Settlement Officer, Myingyan, speaks of it as being associated both with white and red soils.

The fact is that Burman cultivators are fully aware of the damage done by erosion and where land is sufficiently valuable to repay the expenditure incurred terracing is not uncommonly practised. Speaking generally, however, land values are in the main too low throughout the dry zone for terracing to be profitable except in the case of paddy lands. A large proportion of the unirrigated paddy lands of Central Burma have been formed by terracing in gullies and depressions and thus enabling the erosion from higher lands in course of time to produce paddy lands of fair quality.

In Lower Burma and other regions of good rainfall as also in the irrigated tracts of the Province paddy cultivation predominates over all other forms and here the small bunds with which each field is surrounded serve to prevent erosion.

The question of drainage, other than surface drainage, has not yet commanded attention either by the Irrigation Department or by cultivators.

No examination of the question of the conservation of soil moisture has yet been made by this Department. The question, however, has not been lost sight of in the indigenous agriculture of the Province and many of the practices of Burman cultivators in the dry zone show that they have empirically arrived at several of the conclusions now advocated by the most up-to-date exponents of dry farming.

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(10)

NORTH-WEST FRONTIER PROVINCE.

(W. Robertson-Brown, *Agricultural Officer, North-West Frontier Province.*)

(1) *Soil Denudation.* On all submontane land in North-West India the prevention of soil denudation by terracing the land is understood by every cultivator and the system is practised wherever it is practicable,

(2) There is no cultivator who does not know that moisture is conserved by maintaining a loose surface mulch of soil.

(11)

DELHI.

(A. E. P. Griessen, *Superintendent, Arboricultural Operations, Delhi.*)

An object-lesson on the treatment of ravines is afforded by the treatment of the Agra ravines which possess a convincing illustration of the possibilities of checking the erosion from the upland and the denudation of vegetable mould.

When in 1900, the 300 acres of broken land intercepted by ravines 60 to 100 feet wide with depth varying between 20 by 40 feet were handed over to the writer for the laying out of a Park, the greatest difficulty to overcome was to put an immediate stop to the tremendous scouring that took place during the monsoon which for years had undermined this part of the town. The difficulty was greater than at first apparent as several square miles of upland were unnecessarily scouring its beneficial vegetable mould through these ravines.

Huge earthen bunds were at once thrown across these ravines and provision was made for surplusing the water over solid ground so as to discharge the surplus water into the next catchment area. In the course of only two years some of these ravines had silted up to a height of 10 feet. Willows were grown on the bunds with the result that they stand at the present time and have become the foundation of the road system of several of the park roads.

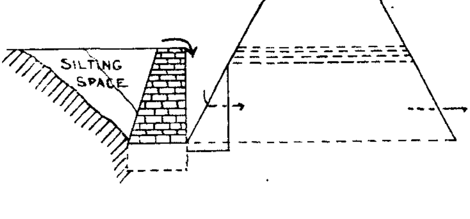
In other instances where the position of the ravines permitted it artificial lakes were made and these now form the storage reservoirs of one of the most perfect garden irrigation schemes of Upper India. These artificial lakes made out of the largest ravines were subsequently connected with the canal and now they collect during the monsoon the greater portion of the upland drainage that used to scour the remains of the old site of Agra into the Jumna and in the summer they are fed from the canal.

In 1901 when Mr. Moreland, the Director of Land Records and Agriculture, United Provinces, visited the work, he expressed his doubt as to the possibility of controlling such an expanse of broken land. Great was, however, his impression when he re-visited the site a few years later.

The main object in view was to retain the rainfall on the land and with a judicious system of plateaus or terraces not only were further erosions averted but the land was secured and now forms a most picturesque part instead of what used to be a most desolate site. The vegetable mould that formerly used to be washed away is now retained. These operations were not limited to the Park area but were also extended to the land known as the Government Grass Farm ; the result can be checked at any time if a reference is made to the old survey.

Wherever terracing is imperative the cultivation of willows, jaint and tamaricks may be advocated owing to their root binding actions. Ten acres of land were similarly also reclaimed from the Jumna in the course of seven years.

Road and Railway making are often responsible for making matters worse as their alignments have often to go across the natural drainage of the country, concentrating the discharge under small bridges and culverts ; this alone is responsible for a lot of scouring. These waterways are, in my opinion, very seldom carefully studied ; in most cases these bridges and culverts, if properly built, could form so many ravine training bunds if retaining walls were built to allow the silting of the upland to the safe level at which water can be made to escape under these structures ; perhaps the following sketch would illustrate my argument more clearly :—

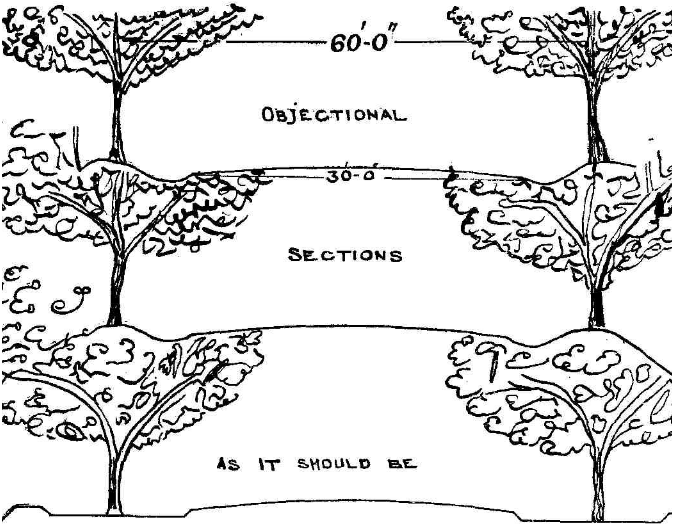


In this way a considerable amount of erosion could be averted. The same theory applies to roadside drainage ; taken at too great a grade without a retaining wall near the culvert it encourages scouring, destroys the side of the roads and very often the adjacent fields.

There is no reason why throughout the plains of Upper India, the road drainage should be allowed to run to waste ; it is appalling to think that in a tract where the rainfall is so scanty that it should be allowed to fritter away without even benefiting the roadside trees.

If the plantation of our roads was judiciously worked out there is no reason why the actual road surface drainage or rainfall could not be utilized for the benefit of the trees planted alongside of them ; it only needs a little forethought. The actual surface rainfall can easily be estimated and taking for instance the average rainfall one can expect in Upper India, some longitudinal trenches or low level *pattries* could easily be made to receive the said rainfall and these *pattries* utilized for tree planting ; thus it would be quite possible to retain the greatest

portion of the road surface drainage. The following sketches will illustrate the prevailing system of road planting and the suggested one :—



This last section would, if properly made and based on the possible amount of water to be retained, utilise most of the road surface rainfall for the benefit of the trees. It must be said that these trenches or depressed *puttries* should not be continuous but divided so as to retain each tree's share of the water ; any overflow may run into the drain at the back. The low *puttries* would soon be clothed with natural grasses and would not only retain the valuable rainfall for the benefit of the trees but would secure the sides of the road from unnecessary erosion.

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(12)

COORG.

Letter Dis. C. No. 116-A., dated the 10th March 1915, from F. Hannyngton, Esq., I.C.S., Commissioner of Coorg, to the Secretary to the Chief Commissioner of Coorg, Bangalore.

With reference to the correspondence ending with your endorsement No. 956, dated 8th April 1914, I have the honour to forward herewith a report on the subject by Mr. G. Haller, Deputy Director, Land Records and Agriculture.

2. His conclusions may be accepted as regards wet cultivation, but I am inclined to think that the stony nature of the soil in East Coorg is due to a certain extent to denudation caused by the removal of forests and by bringing the land under cultivation. The rainfall is often heavy and the soil is very light with a rocky sub-soil.

3. Abandoned coffee either on the plateau or the Western slopes does not resume its original forest aspect as stated by Mr. Haller but becomes overgrown with thick masses of lantana. This prevents surface wash, but on the slopes, the mischief has been already done and the rich humus disclosed when the forests were felled has all been carried down the steep hill-sides. It is possible that the evergreen forest may begin to re-assert itself in another 50 years. Meanwhile the lantana certainly does protect whatever soil has been left.

4. Draining and terracing have so far been found impracticable in the case of tea cultivation, but it is too early yet to say whether the local system denudes the soil to a dangerous extent. Light shade is being planted for the tea and this will act as a natural canopy. Further, the tea has not been planted on steep slopes as in Ceylon but on undulating ground and I do not consider that terracing should be enforced by regulation for the present at all events.

5. On the whole, I do not think that legislation is indicated as a remedy for the comparatively small amount of denudation now going on. The large amount of *bane* land, purposely kept uncultivated and overgrown with jungle checks denudation and protects the springs. If such land were ever to come under cultivation, terracing would, no doubt, have to be insisted upon.

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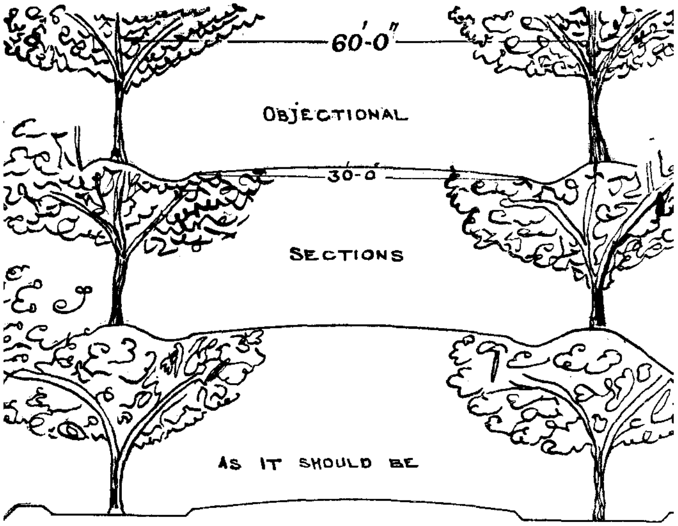

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T.

(G. Haller, *Deputy Director of Land Records and Agriculture.*)

1. The main circumstances for consideration of the points bearing on soil denudation by rainfall and drainage and the conservation of soils in Coorg appear to be: (*a*) rainfall, (*b*) method of cultivation, and (*c*) protection against soil denudation.

2. *Rainfall.* The rainfall in this province is heaviest near the ghats and decreases very rapidly towards the east and ranges between 210 and 40 inches. It reaches, however, in the western slopes of the ghats, which are chiefly covered with evergreen forest as much as 400 inches per annum. About 90 per cent. of the rain is precipitated during the monsoon from June to October.

Method of Cultivation.

3. (A) *Wet Cultivation.* The method of cultivation varies for the different crops, namely, wet, dry, cardamoms, oranges, coffee, rubber and tea. The area under (A) wet cultivation is approximately 97,860 acres. The ryot appears to have realized in the earliest periods the importance of protecting his fields from soil denudation, which is indicated by the Coorg proverb: "water which passes through the bund will never return." We find, indeed, that all paddy fields are carefully terraced and protected according to the steepness of the land with bunds varying in breadth and strength. An additional protection is afforded by drains which catch the water rushing down from the surrounding slopes and hills during the rains. The rice lands are also divided, according to the steepness of the ground, into small compartments of the average size of 25 cents., each of which deals with its own rainfall thereby preventing loss of soil and manure. In spite of these precautions it is a recognised fact that low-lying lands are more valuable on account of the greater manurial deposits which accumulate in them from high-lying lands: the constant repairs of the bunds are considered, therefore, to be one of the most important works attendant on rice cultivation. I do not believe that anything more can be done than is at present the case.

(B) *Dry Cultivation.* Of which there is an area of 21,000 acres in Coorg confined entirely to the eastern parts of the Province where the rainfall is small. The country is plain and each field is protected, similar to wetlands by bunds on which in most cases hedges are grown. Ploughiug is invariably done when it is not raining and the loss of soil is, therefore, negligible.

(C) *Cardamom Cultivation.* The cultivation of cardamoms is spread over an area of roughly 10,000 acres. The usual indigenous way of raising cardamoms is by felling a few huge trees, under which rich leaf mould is found. The soil is in no ways disturbed, and the plant springs up spontaneously and requires no further care and attention except weeding. These plots, of an average size of $\frac{1}{10}$th to $\frac{1}{6}$th of an acre, are scattered all over the forest, but the "improved method" which is now generally resorted to by big proprietors, consists of the raising of seedlings in nurseries, where they remain for two years after which they are transplanted, only the undergrowth being cleared. It is obvious that surface washing by even the heaviest rainfall is impossible.

(D) *Orange Cultivation.* Orange cultivation although only 4.250 acres in all, may be conveniently considered next. It is generally done in abandoned coffee lands, and at times in grass slopes or thin forest land. The plants are raised from seed which, after remaining in the nurseries for about three years are transplanted 16 by 16 feet apart, in pits two feet square, which are covered with good soil to within six inches from the surrounding surface. The surrounding land is undisturbed and used for grazing. There can then be no loss of soil.

The cultivation of wet and dry crops cardamoms and oranges may, therefore, be safely dismissed without further consideration.

(E) *Coffee.* The position of the other crops present far greater difficulties. As regards coffee cultivation it is at present carried on by methods known locally as "European" and "Native" and generally as the "Shade system" which replaced the "open coffee" sytem about 40 years ago. Under the "Native system" coffee is planted under primeval shade, the undergrowth only being cleared. Except a digging and removing of weeds, no further attention is paid to the coffee bush, which is allowed to grow unchecked, and the knife is not even applied to remove dry or useless wood. The "European method" is carried on scientific principles, both as regards cultivation and manuring. The jungle is felled and burned, and seedlings raised in nurseries are transplanted in accurate rows.

Concurrently with the planting of coffee the soil is replanted with a variety of quick growing forest species of a type, in many cases superior to the original ones, and the overhead canopy at a height of 40 to 50 feet is complete in the course of a few years, the coffee bushes themselves forming a dense layer of interlacing evergreen vegetation to protect the soil. On the other hand these estates are well provided with numerous roads and drains so that a wash of soil, or rush of running water is minimised to the smallest possible extent. Terracing is not possible, as water-logging is fatal to the coffee bush.

There are now 3,904 acres under the Native method and 38,591 acres under the European method of cultivation. In addition to this there are 37,963 acres on which coffee cultivation under these systems has been abandoned. Such land is rapidly reverting to its original forest aspect, and especially in the case of the abandoned coffee in "native" estates the original forest aspect has so completely been restored, that all traces of former cultivation have been entirely effaced.

It is unfortunately quite a different matter with the "Open coffee" method, which was nothing less than a calamity to Coorg. Under it about 30,000 acres of the finest evergreen forest upon the slopes of the western ghats were clean felled, planted up and in a few years, owing to the denudation of the rich surface soil, totally abandoned. This large area is now almost exclusively covered by the lantana shrub, which is frequently attacked by jungle fires, involving the destruction of young tree growth so that in all probability the reafforestation of it might require centuries. There is a division of opinion as to whether lantana is a soil restorer. The successful replanting of such land appears to be in favour of lantana, but as its roots do not extend to more than 9 inches or a foot below the soil surface, it cannot be of very great value.

As practically all land suitable for coffee has already been taken up, no appreciable extensions of such cultivation is possible in Coorg.

Summarising the above I believe that more cannot be done in the way of soil preservation for coffee cultivation.

(F) *Rubber Cultivation.* Rubber cultivation was commenced in Coorg in 1906 and the varieties planted are Para and Ceara. The latter is entirely confined to the areas formerly under coffee, and covers 3,797 acres. Para is planted on the western slopes of the ghats in evergreen forest land; and there are at present 1,692 acres under it of the 2,745 acres demised for its cultivation. The system of cultivation for both varieties resembles the old system of "open coffee" cultivation, as the primeval forest, and with it the old vegetation, is clean felled and burnt. The surface of the ground is kept clean of undergrowth. Except at the very start, the soil is rarely disturbed by digging, which is generally done at end of the monsoon with the object of destroying weeds and grass. The cultivation is to a large extent devoid of protection against soil denudation and there can be no doubt that a certain amount of soil denudation is unavoidable and that it must be considerable at the start when the trees are young.

(G) *Tea.* The latest industry in Coorg is tea cultivation. It was tried 15 years ago in abandoned coffee land in the western (Sampaji) ghat but failed. The exact cause for its failure has not been clearly proved, *i.e.*, bad cultivation, or unsuitable climate and soil? It is, however, possible that the fault lies in the climate and soil as recent attempts in that locality were unsuccessful. Two years ago virgin forest has been taken up by a company in South Coorg for tea cultivation and its management is conducted by an expert in tea cultivation. A small area (about 200 acres) has been brought under cultivation which resembles very closely "European method" of coffee cultivation, with the exception that the prospective shade will be considerably lighter than what is adopted for coffee. The soil denudation will, therefore, be greater until the tea bush has well developed. This disadvantage is, however,

quite incommensurate with the great advantage accruing to the support of a number of labourers, as well as of ryots living in the neighbourhood who earn something in addition to what their paddy fields yield.

Any interference with the method of cultivation would be seriously objected to, especially as nothing better can be suggested.

4. *Conclusion.* It cannot be denied, that a certain amount of soil denudation is taking place in spite of all the precautionary measures. This important subject was formerly completely disregarded in the case of coffee cultivation, but the planter and the ryot are now well aware of the immense loss, which washes by rains cause to their property and every reasonable care is taken to prevent it. Undoubtedly improvements might be suggested for the protection of the soil, but will this suit the cultivation? And would it be wise to impose additional burdens in view of the troubles, which the landholders have had in recent years with regard to the tight money market, insect pests and labour difficulties? I think it best to leave well alone.

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(13)

(G. D. Hope, B.Sc., Ph.D., *Chief Scientific Officer, Indian Tea Association.*)

The question of soil erosion in India, in most of its aspects, has been discussed recently by the Imperial Economic Botanist, and this note is submitted only because it contains a few observations on the way in which soil erosion is dealt with in a neighbouring country where the problem is of great importance and in many respects similar, and because it may help to identify the agriculture of tea with that of other crops in India in respect of the necessity for improving existing methods of prevention of loss of soil by wash. Although there are many features of tea cultivation which make tea a thing apart from other agricultural operations in India, this is a point where the interests of tea planters are identical with those of other agriculturists.

The retention of soil on sloping land by prevention of wash is of considerable importance to the tea industry of North-East India not only in Darjeeling, where land slopes very steeply, but in other parts of the tea districts where estates are generally fairly level.

The conditions under which soil erosion takes place in the different tea districts of North-East India may be described as follows:—

In Assam tea land is usually level but it is intersected by "Hullas" or *nullahs* (natural depressions which take off surface drainage), some of which are filled with jungle, while rice is grown in others. Tea, which has been planted for many years on the edges of such "Hullas," shows, in most cases, unmistakable signs of having suffered from the soil erosion which has taken place.

In the Dooars tea land consists of a bank of heavy loam extending several miles from the foot of the Himalaya southwards towards the plains and below this of level land, the soil of which is in most places grey and sandy. There is a definite drop of a hundred feet or more from this red bank to the plain below and similar breaks occur at places in the red bank itself. The tea land of the Dooars is intersected by rivers which flow directly from gorges in the hills, and in time of heavy rain these are rapidly flowing torrents; in the cold weather they are almost dry. These rivers often alter their line of flow and tea consequently is not usually grown near their banks. In many places near the hills the surface of the stiff red clay loam soil is undulating. It is on this red bank that the most serious problems of soil erosion have to be faced, and, with a rainfall sometimes as high as 200 inches per annum, and confined chiefly to a few months in the year the loss by wash is considerable. The fertility of this red soil suffers very seriously when wash has taken place.

In Cachar and Sylhet a particular feature of tea lands is the presence of steep rounded *tilas* (low hills projecting from the level plain) interspersed among flats of different and more recent soil. The *tilas* are sometimes quite sandy, sometimes gravelly, but often of fairly stiff clayey soil. The soil of the flats ranges between a heavy intractable clay and a coarse sand poor chemically. A special type of such flats are the drained *bheels* (peat bogs) in which the percentage of organic matter may range between 15 and 70 per cent. The prevention of soil erosion is of particular importance in this district in connection with the loss of the fertility of the *tilas*.

In Darjeeling the soil at higher elevations usually consists of a heavy reddish clay and that at the highest elevations is overlaid by a fairly deep humus layer and wash is not very serious. At medium elevations this clay suffers from wash and the fertility of the land has consequently deteriorated. At medium elevations also some very sandy soils occur and these have suffered very considerably from wash. At lower elevations near rivers where the land is less steeply sloping some rich alluvial sandy stretches are found which have been formed at the expense of the fertility of the ridges and hill-sides above.

Throughout the tea districts with the exception of a few gardens in Darjeeling and on some of the *tilas* in Cachar and Sylhet the arrangement of tea bushes is in square or triangular alignment and, in solving the problem of protecting estates from loss of fertility by soil erosion, the treatment of considerable areas of old tea planted in this manner (a most objectionable one on land where serious loss of soil by wash is likely to take place) many years ago has to be considered, in addition to devising the best means of laying out and planting such slopes on land which is being put under tea for the first time.

At the end of the year 1913 the writer spent some weeks in Java and Sumatra and was much impressed by the means which are taken in these countries to prevent loss of surface soil by wash on tea estates as compared with the efforts made to this end in Ceylon and North-East India.

The whole of the tea districts of Java are sloping land and it is the invariable custom to plant tea fairly closely on contour lines as distinguished from square or triangular arrangement, the result being that in no cases are there spaces between the bushes in straight lines of any length down slopes such as can be seen on every tea estate in Ceylon and on many estates on sloping ground in North-East India where the planting is in square or triangular alignment. Contour planting is undoubtedly the better method whenever there is possibility of serious erosion.

This being the first step taken by Java planters, other means are adopted according to the nature of the land, and these consist in terracing, where the land is steeply sloping, and in arranging a system of contour drains, contour hedges of suitable leguminous plants, and series of catch-trenches in contour alignment in less steeply sloping situations.

Opinions differ in different parts of the world as to the value of terraces, a fact which seems to indicate that there may be some factor as yet not fully understood which accounts for terraces being of use in some places while in others their value appears to be doubtful. In Ceylon tea estates terraces are rarely seen in spite of the fact that much of the tea land is more steeply sloping than on most estates in Java. It is surprising that in Ceylon the terracing, which is so picturesque a feature of the journey from Colombo to Kandy, has not been copied on tea estates and the omission has undoubtedly been an error in judgment though it has been a still greater mistake to have adopted linear instead of contour planting on sloping ground.

In Java, certainly, nearly everyone is persuaded of the value of terraces on steeply sloping ground.

Opinions differ in Java as to whether terraces should be made before the tea is planted or afterwards. The argument in favour of making the terraces before planting the tea is that the work can then be done carefully and completely without any disturbing factors, and, being done, is done once for all, and when the tea is eventually planted it merely remains to adopt an efficient system of keeping terraces in order. Those who are in favour of making the terraces after planting out the tea base their argument on the fact that in such cases the tea

is planted in surface and not in subsoil, and that if the weeds, when they are gathered, are regularly placed between the rows of tea, planted in contour lines, terraces form of themselves and are in all respects as efficient as those made more expensively before the planting out of the tea. It is possible, however, to make terraces before the tea is planted out, in such a way that the seedling plants are put into surface and not into subsoil and it is more satisfactory from several points of view to make terraces before the seedlings are planted. (*see* Sketch 1.)

Terraces having been made the upkeep of them is a matter of great importance. In Java many different plants are used to protect the edges and faces of terraces and are either planted there directly or, if of naturally occurring species, are encouraged to grow in preference to other plants by a process of selective weeding of the terrace faces. Species of Hydrocotyle, Viola, Desmodium, etc., are commonly seen grown in this way.

On fairly broad terraces it is often the custom to dig short trenches at intervals along the inner edge of each terrace and these serve to catch the wash which comes from the terrace above. These catch trenches are cleaned out when the terraces are weeded, and the earth which has collected in them is thrown up on to the terrace above. (*see* Sketch 2).

The system is an excellent one under Java conditions where weeding and forking, instead of hoeing, is the method of cultivation.

A similar system of catch trenches is employed largely in cases where the land is not steep enough to terrace. The method there generally adopted is one of alternate contour lines of catch trenches and of green crops, sometimes with one and sometimes with two lines of tea between them. In such cases the positions of the catch trenches, which are usually about 12 feet long by 1 foot broad by 1½ feet deep, alternate with 12 feet intervals along the contours, and are arranged in echelon with those next above or below along different trenched contours, so that if any earth is carried beyond one line of catch trenches and past the intermediate tea bushes and green crop hedge, it will eventually be caught in the next catch trench below (*see* Sketch 3). When these catch trenches are cleaned out, which is usually done at the time of weeding, the earth is thrown up the slope.

Leguminous plants such as *Leucaena glauca, Clitoria cajanifolia, Tephrosia purpurea*, etc., are the plants most commonly used for the hedges which alternate with the catch trenches.

Combined with this is a careful system of drainage.

The main drain system—it must be remembered that almost without exception fairly steepy sloping ground is under consideration, consists of "hoeft afvoergoten" (main drains) which lead directly down the slopes. It is considered most important in connection with the drainage system to remove, as far as possible, the excess water which cannot sink into the ground sufficiently rapidly in case of heavy showers.

The soils of Java are very porous and when slight showers fall the rain sinks rapidly into the ground, but the soil is also very rapidly washed down by water flowing over the surface of the ground, if all the rain water is not immediately removed when heavy rain falls. This is at once the advantage and the danger of the soil of Java.

To prevent this loss by wash, it is considered of primary importance to have an escapement for excess water, and the main drains straight down the slopes serve this purpose best for they ensure the rapid removal of water at places which are chosen for the purpose, and not at places where the rush of water may do damage.

The best situations for some of these drains are the places where there are natural gullies down the concave folds of the hill-sides. Where these gullies are pronounced in character one usually finds either rocky ravines, or rather water-logged patches filled with deep rich soil which has been carried there by wash before the opening up of the land. The stone ravines can be used as drains without much being done to them. They are straightened and cleaned out to some extent to facilitate the rapid removal of water. Gullies which are filled with deep earth, when drained, add to the area in which tea can be planted. The sides of these drains are protected by growing grass on them and the rush of water down them is stopped by a series of low barriers of stones, bamboos, etc. A certain number of "hoeft afvoergoten" have also to be made at intermediate positions between the gullies and the distance between two "hoeft afvoergoten" is usually not to be more than 100—200 yards.

The collection of the water into these main drains is carried out by means of contour drains called "afvoergoten" and these are usually made with a very slight gradient, the object being merely to catch the water and remove it into the "hoeft afvoergoten" or main drains. These "afvoergoten" are laid out very carefully on Dutch estates in Java, and are flanked on the upper and lower sides by banks on which suitable leguminous plants are grown. Grass is often grown on the sides of the drains themselves. They are cleaned out periodically for the danger of water breaking through must be carefully avoided since it would cause great damage because it would mean the escapement of water down hill at a point for which preparation for its control had not been made (*see* Sketches 4 and 5).

Modifications of one or other of these methods is the system adopted in Java for the prevention of wash, and in some of the new tea estates which are being started in Sumatra.

There is some difference of opinion in Java as to the extent to which cultivation is a factor in aggravating loss of surface soil by wash. Some claim that if soil be cultivated at times of the year when there is much rain, the rain, instead of washing the soil with it down the slopes, sinks into the ground and thus wash would be prevented. Others say that if the soil is undisturbed, and particularly if it be protected with a slight covering of jungle, wash will be inappreciable, whereas it will be considerably greater if the soil has been recently cultivated and is broken up and free of jungle growth. I think very much depends on the nature of the soil and that this is a subject which might receive study in connection with loss of soil by wash in India; that is to say it would be worth, while to determine, in districts where loss of surface soil by wash is known to be great, the effect of cultivation in aggravating or reducing the amount of wash and to correlate this information with data bearing on the mechanical composition and physical properties of the soil.

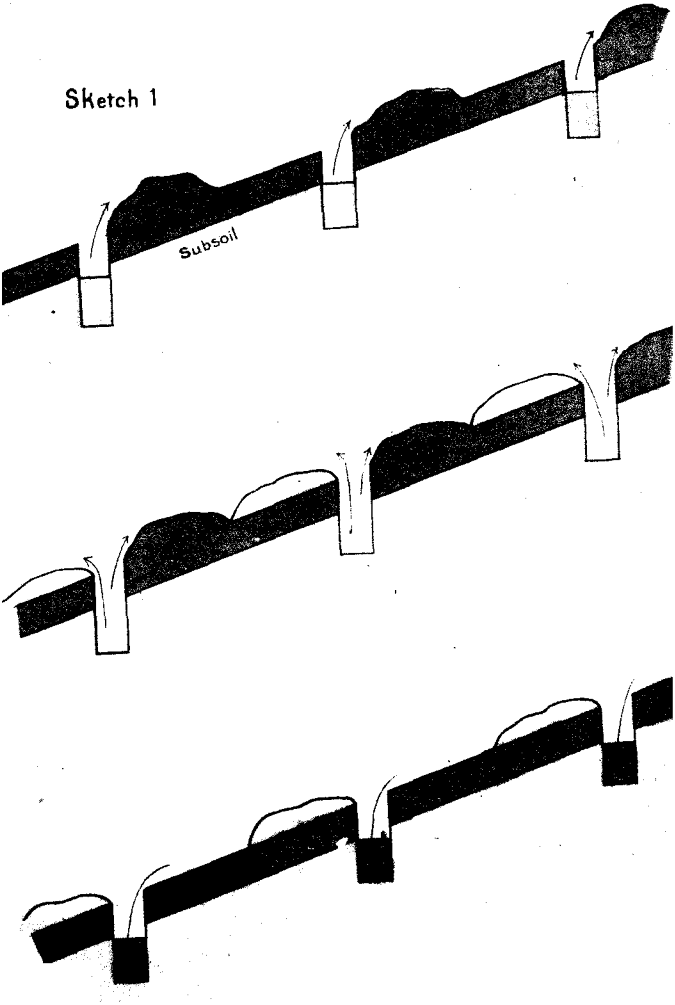
There is another point which has so far been left out of discussion on the subject of soil denudation in India and that is the extent to which dry wash,—that is movement of particles of soil down hill in dry weather as the effect of wind—takes place. In Java, I believe, this dry wash takes place chiefly at medium elevations where the soil is loamy in character but is of sufficiently good tilth to pulverise on the surface in dry weather. The compact soil immediately below the loose layer on the surface affords a comparatively smooth plane down which detached particles of surface soil are blown by wind. These particles collect behind tea bushes and stones and on the flat faces of terrace and are washed down in the form of mud by the first heavy shower of rain.

The extent of the loss of soil which is going on steadily this way in dry weather is undoubtedly very great in some districts of Java, and it would be interesting to determine whether a similar phenomenon takes place to any great extent in India and in what localities it occurs particularly.

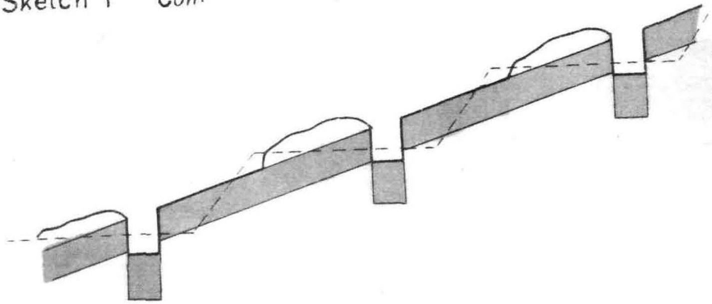
Speaking of tea planting only I say emphatically that the methods employed in Java appeal to me as being the best that can be done to prevent loss of surface soil, and although it is a matter of great expense and trouble, yet where tropical agriculture is becoming yearly more intensive and new land cannot be obtained to replace by new clearances the older parts of existing estates, all that can be done to prevent loss of surface soil on existing estates has a very great commercial value.

The measures adopted for the prevention of wash in the tea districts of Ceylon and North-East India appear to me to be largely wrong or inadequate.

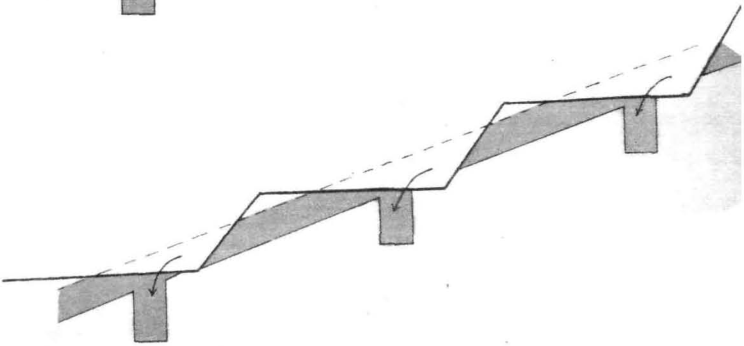
Sketch 1



Sketch I Cont.



1.



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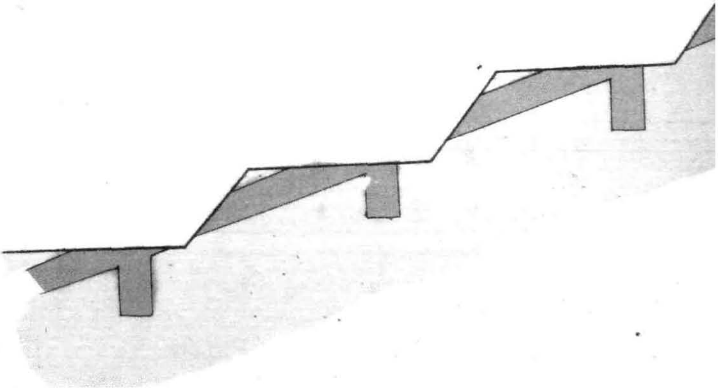
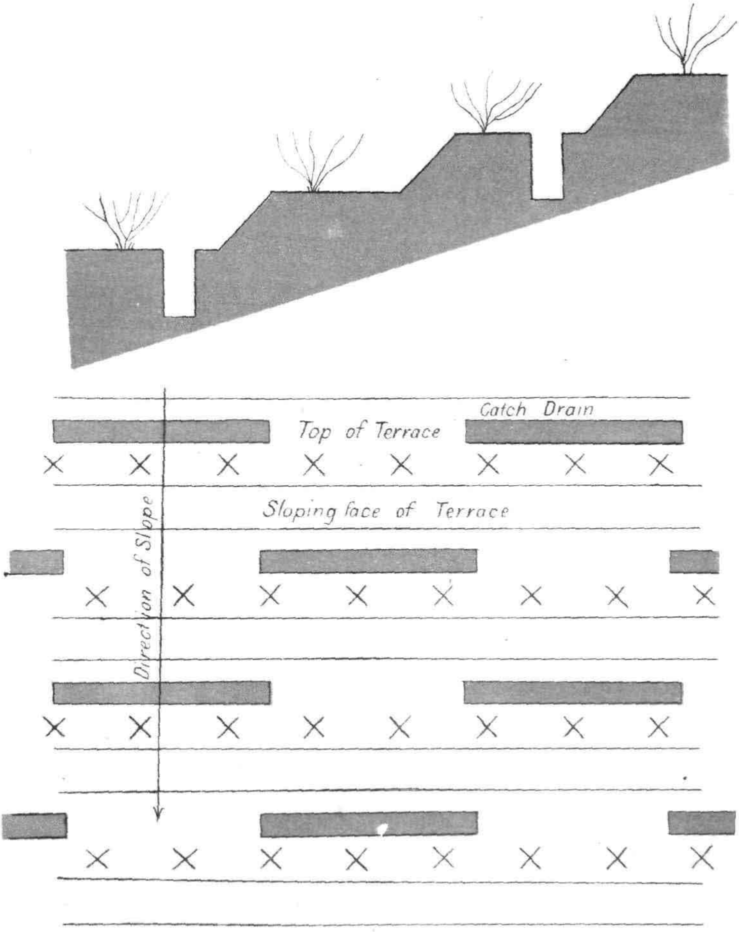
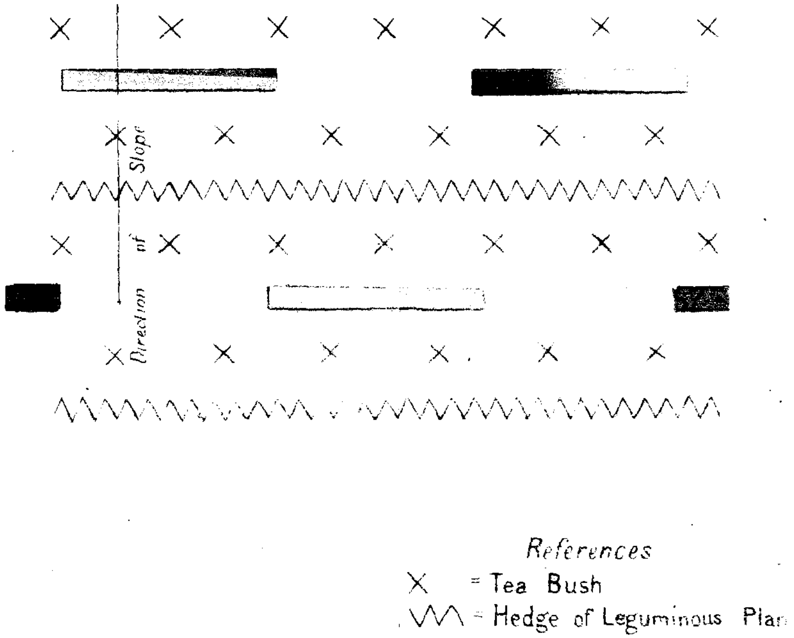


Sketch 2 *Plan & Elevation*

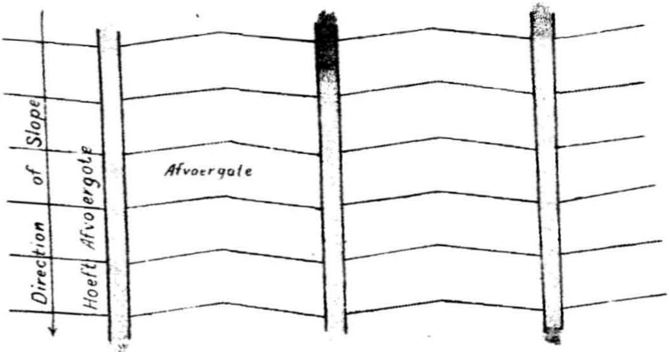


Reference
X = *Tea Bush*

Sketch 3 PLAN

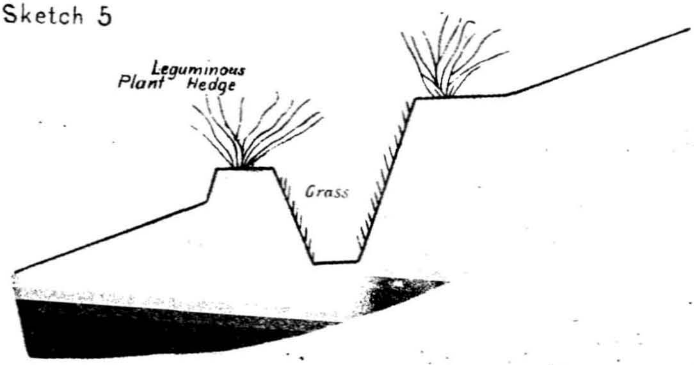


Sketch 4 *Diagrammatic Plan of Drainage of a Slope*



Elevation Afvoergote

Sketch 5



APPENDIX B.

Subject VII.—Memorandum on the reorganization of the Veterinary Department, Bihar and Orissa.

(G. MILNE, I.C.S., *Director of Agriculture, Bihar and Orissa.*)

1. In Bihar and Orissa the reorganization of the Veterinary Department has been under consideration since the formation of the Province in 1912. Up-to-date no final conclusions have been reached by Government, who are at present consulting local bodies on a scheme tentatively approved. While this scheme would mark a very distinct advance, and would in particular improve the prospects of the Veterinary staff, I find myself unable to hope that, worked on the present lines, even with the addition of more European supervision, the Veterinary Department will succeed in eradicating the epidemic diseases which annually cause grievous loss to the cultivating population, I therefore put my views on record and submitted them on Government unofficially, with a view to the reconsideration of the policy.

These views are recorded in the following note written in December 1914, and represent my personal opinion of the manner in which the problems before the Department in Bihar and Orissa should be faced. Government have deferred consideration of them principally on account of financial stringency.

2. In the first place, by way of justification of a much more efficient veterinary service capable of controlling and ultimately eradicating cattle-disease, I reproduced paragraph 3 of my letter No. 6375-A., dated the 18th—21st November 1913 and invited attention to the figures of area, population, cattle statistics (bullocks only) and expenditure. Any who doubt the necessity of larger expenditure on veterinary relief are referred to the weekly weather and crop reports that appear in the Gazette. That for the past week (December 1914), stated that there was cattle-disease in 16 out of 21 districts, and that there may be no misapprehension on the question whether these epidemics are being efficiently handled with the existing staff, I quoted the statement regarding rinderpest from the Veterinary Report of 1913-14, *viz.*, that 1,525 outbreaks were reported, of which only 369 or 24·1 per cent. could be attended. The figures of 1912-13 were even less encouraging, since the percentage of reported outbreaks at which inoculation *was effected, amounted, again in the case of rinderpest alone, to only 15·6. These statements neglect Hæmorrhagic* Septicæmia—a very virulent and widespread disease—and it must always be remembered that reporting of outbreaks is inefficient and dilatory as we are coming more and more to learn through the agency of Co-operative Central Banks.

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" In the first place, it is necessary to examine our position in regard to expenditure on veterinary matters as compared with the expenditure of other provinces. In the statistics that follow, the area of Native States has been included as well as British territories, inasmuch as while it is impossible to neglect the area of the States in considering the capability of an officer to tour efficiently in his charge, it will also be found ultimately impossible to neglect the cattle therein, because of the fact that these States will form centres of infection from which cattle-disease will be propagated in British territory :—

Province		Area	Population	Bullocks only	Total expenditure	Number of European supervising staff
1		2	3	4	5	6
					Rs.	
Punjab	British Territory	99,779	19,974,956	4,428,493	5,10,935	3+1 for college.
	Native States	36,551	4,212,794	..	..	
	TOTAL	136,330	24,187,750	..	..	..
Burma	British Territory	230,839	12,115,217	1,774,720	2,33,557	2
Central Provinces	British Territory	99,823	13,916,308	3,101,501	1,58,033	2+1 on training.
	Native States	31,174	2,117,002	..	..	
	TOTAL	130,997	16,023,310	..	..	
United Provinces	British Territory	107,267	47,182,044	10,420,480	93,938	2
	Native States	5,079	832,036	..	..	
	TOTAL	[illegible]2,346	48,014,080	..	..	
Bihar and Orissa	British Territory	83,181	34,490,084	5,960,856	59,000	1
	Native States	28,648	3,945,209	..	..	
	TOTAL	111,829	38,435,293	..	..	

" The figures of cost from Table XVI of the compilation prepared by the Government of India from the reports of the Provincial Civil Veterinary Departments appear to have been compiled on varying principles and do not carry conviction. With regard to column 4 showing number of bullocks I would remark that the statistics probably do not do justice to Bihar and Orissa, inasmuch as in the four other provinces a local revenue agency exists by which the number of cattle is annually reported, and the figures are approximately accurate and up-to-date. In Bihar and Orissa there is no such agency and hitherto statistics have been obtained by the police from the local chaukidars. Our statistics are almost certain to be an underestimate and not to err in the contrary direction. Taking them for

what they are worth, however, it appears that Bihar and Orissa has approximately twice as many cattle as the Central Provinces, one-third more than the Punjab, three times as many as Burma, while the United Provinces give a return showing about 4½ million more than in Bihar and Orissa. Full information is not available regarding the staff in the different provinces, but I find that in the Central Provinces it is considered that three Superintendents will ultimately be necessary with a staff of six Deputy Superintendents, 22 Inspectors and 121 Assistants and of these *that province has already appointed one Deputy Superintendent, six Inspectors and 100 Veterinary* Assistants. The sanctioned cadre in this province allows for two Deputy Superintendents, 12 Inspectors, 60 Stationary and 60 Itinerant Veterinary Assistants with 13 as a Reserve or 133 Assistants in all. This scheme was not framed by the present Government, but emanated in 1910 from the Government of Bengal, the province of Bihar and Orissa taking in 1912 its proportion of the sanctioned cadre according to districts. It will be seen that in comparison with the population and cattle to be dealt with the estimate framed by the Central Provinces Administration and sanctioned by the Government of India is on a far more liberal scale than that proposed by the Government of Bengal. A great difference lies in the fact that the administrative units in the Central Provinces are of much smaller extent and especially much less thickly populated than in Bengal or Bihar.

" The total expenditure by the Local Government in 1911-12 on veterinary work in Bihar and Orissa amounted to Rs. 59,000, including contribution of Rs. 20,000 on account of the Belgachia College, but excluding Rs. 14,000 on account of superintendence (Imperial). The expenditure by District Boards amounted to Rs. 47,430 which sum is no more than ·97 per cent. of the total income of those bodies for the same year. I consider it obvious that with these sums neither Government nor local bodies are doing sufficient for the protection of the agricultural live-stock of the province. It is now a common-place that the value of cattle in India, and indeed all over the world, has risen very greatly of recent years. In Bihar and Orissa prices have more than doubled within forty years. It used to be possible to buy a satisfactory pair of stoutworking bullocks for Rs. 120 to Rs. 150, but at the Sonepur *fair of this year extraordinary prices are being given* by Bengal dealers—more than twice the amounts quoted above. In North Bihar, where are the important breeding and exporting tracts, we have of recent years been fortunate in escaping rinderpest, but there have recently been signs of introduction of that disease from the United Provinces in the herds of cattle which annually pass through Bihar and Orissa on their way to Bengal, and should the province be visited with a severe epidemic and suffer a heavy loss in cattle, this would go a great way to destroy the good effects of the agricultural prosperity of the last few years. The above considerations point to the necessity of providing betimes against the depletion of this source of wealth by taking steps to strengthen the veterinary staff."*

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3. *These facts were recorded in* 1913. *Late in* 1914 my suggestions were that Government should organise (1) a superior service of Veterinary Assistants posted to the charge of subdivisions, and (2) an inferior service of Veterinary Assistants trained for 18 months to 2 years in the vernacular and selected carefully from the agricultural classes that by heredity are closely in touch with cattle and are familiar with their ailments and the local methods of handling them. Such men exist in every district of the province and belong particularly to the caste of *Goalas* or *Ahirs*, which is so powerful in Bihar and Orissa. There are over 3,233,000 *Goalas* in British territory alone, and of these 2,898,000 are found in North and South Bihar, where they form the remarkable percentage of 12·2 of the whole population. In the Chota Nagpur Division there are 334,000 *Goalas* or *Ahirs*, and of these 149,000 are found in the Hazaribagh district—immigrants from Shahabad, Patna and Gaya ; the other Chota Nagpur districts have each an average of about 42,000 *Goalas*. In Orissa the corresponding caste is *Gaura* or *Gopal*, of whom there are 715,000 and the vernacular Veterinary Assistant would in Orissa be chosen from that caste since they are the hereditary cow-keepers and cattle-owners in that part of the province. Other suitable castes in Orissa are *Chasas*, corresponding to *Kurmis* in Bihar (847,000), and *Khandaits* who claim to be Kshatryas or Rajputs (805,000). In North Bihar recruitment of Veterinary Assistants need by no means be restricted to the *Goala* or *Ahir* caste, but suitable *Koiris Kurmis, Rajputs, Babhans, Hajams* and cultivating Muhammadans can be taken in, in addition to the pre-eminent cow-keeping caste. In the Chota Nagpur Division recruitment would be made amongst the immigrant *Goalas*, but principally from the local Mundas, Oraons, Santals and other aboriginal tribes. The standard of education that would be taken as the normal will in all cases be the Middle Vernacular or Middle English School certificate. My conception of the Veterinary Service, we should have ultimately in Bihar and Orissa, is somewhat as follows :—There should be a highly trained Superintendent recruited in Europe for each division. Possibly an Indian might in time be found efficient enough to be placed in charge of one division out of the five. One of the five Superintendents will be styled the Chief Superintendent and would exercise a general supervision over the four Superintendents, *while himself holding charge of the* headquarters division, with a *particularly efficient Deputy Superintendent* to assist him. The other four Superintendents would also each have under his orders a Deputy Superintendent who would be a native of India and who would assist in office work and at the same time tour in the division and carry out such inspections and investigations as the Superintendent might consider desirable. In each large and important district there should be one Veterinary Inspector. Where districts are small in area and population, one Inspector for two districts might suffice. In each subdivision would be posted a Veterinary Assistant educated in English and trained for four years. With regard to men at present in service who now number 75 in all, such of them as do not come up to the standard I propose ultimately to reach, would be selected and returned at present to the Belgachia College for a course of retraining under Major Smith, who would keep them until he was satisfied with their professional attainments and efficiency. When in Calcutta I verbally consulted Major Smith on the details of this scheme and found that his ideas coincided with my own as regards the necessity of a system of periodical training subsequent to graduation for veterinary officers posted to the mufassil. Such a system forms part of the general arrangements of the Medical Department to maintain the efficiency of Hospital Assistants and Assistant Surgeons, *who are required (1) to pass an examination in order to qualify for promotion, and (2) are on occasion* deputed for a course of special post-graduate training at the Medical College Hospital in Calcutta. To continue, under each English educated Veterinary Assistant in charge of a subdivision, I would post a Veterinary Assistant trained in the vernacular for 18 months to 2 years to each *thana* more or less in the province. These men would be specially and carefully selected in consultation with the District Officer in each district from the agricultural classes above alluded to and would receive pay on a scale of Rs. 12—20 rising at the rate of Rs. 2 by quinquennial increments, *plus* a proportion of 10 per cent. of the total cadre on a special pay of Rs. 25 a month. All these officers from Inspector to Vernacular Veterinary Assistants would be in the service of Government, but lent to District Boards as under the present arrangement, calculation being made by the Accountant-General to determine the contribution that should be paid by the District Board for the services of each class of men. Only the Deputy Superintendents and Superintendents in charge of divisions would be wholly paid by Government, although indeed there appears to be no sufficient reason why District Boards should not make contributions for the support of these officers as well as for the officers of the lower grades. Statements I and II are attached showing the financial effect in *either case. There should be an Inspector in each district of the province except possibly* Manbhum, Singhbhum, Angul and Sambalpur in which one Inspector for Manbhum and Singhbhum and another for Angul and Sambalpur may be sufficient, judging by the returns showing the number of cattle to be attended to in each of these districts. The difficulty, however, is that both Manbhum and Singhbhum are large districts and communications particularly in Singhbhum, are far from good. The same applies even more strongly to Angul and Sambalpur. The district of Angul is split up into the two subdivisions of Angul and the Khondmals, which are separated one from the other by the Mahanadi river and the Orissa Feudatory States of Daspalla, Baud and Athmallik, while from the headquarters of Angul to the headquarters of the Sambalpur district—a journey which must be performed by road since railway communications are non-existent—there is a distance of not less than 80 miles. Further, the district of Sambalpur is long and narrow, stretching, from the north-east to the south-west corner, for not less than 150 miles, and railway communication south of the Mahanadi is again non-existent. It appears obvious therefore that even

* The apprehensions expressed in November 1913 have unfortunately proved to be well-founded since a serious outbreak of rinderpest originating in Nepal, which began in May 1914 in Bettiah and was not properly reported or dealt with till September, has caused great mortality in the subdivision and shows signs of spreading throughout the province in spite of vigorous endeavours to control it with the inadequate staff at the Superintendent's disposal.

in these districts in which the cattle population is small an Inspector should be provided, unless it is held that as a beginning, except in Manbhum, the intermediate grade of an Inspector should be dispensed with, the subdivisional Veterinary Assistants and the Vernacular Veterinary Assistants being left to the control of the Deputy Superintendent and the Divisional Superintendent. The statements have been drawn on the assumption that there is to be an Inspector in each district.

4. With regard to the Veterinary Assistants now actually employed, the present situation is that the sanctioned cadre allows of one Stationary and one Itinerant Veterinary Assistant for each of the 60 subdivisions in the province, as it stood on 1st April 1912, since which date two subdivisions have been opened at Chatra in Hazaribagh and Simdega in the Ranchi district. The cadre of Veterinary Assistants in 1912, therefore, numbered 120 *plus* 10 per cent. or 13 reserve Veterinary Assistants, the one extra Veterinary Assistant being allowed on account of the 12 Inspectors provided for in the proportion of the cadre that fell to Bihar and Orissa on the separation from Bengal. At the present time the actual situation is that seven Inspectors are sanctioned. With regard to Veterinary Assistants 64 men are actually employed, *plus* two reserve Veterinary Assistants now working as Inspectors of inoculators in Ranchi and two deputed to the Allahabad Military dairy and the Belgachia Veterinary College for training. No men are available as reserve Veterinary Assistants and no men have been found to fill up the balance of the posts sanctioned, *i.e.*, 75 posts in all, apart from posts of reserve Veterinary Assistants paid wholly by Government. Under the scheme above outlined 62 men of the superior Veterinary service will be required at the rate of one for each subdivision. To this must be added 10 per cent. of leave reserve making 68 in all. Similarly 21 Inspectors are required, at the rate of one to each district, with a leave reserve again of 10 per cent. making 23 in all or as in the existing scheme the leave reserve of Veterinary Assistants may be raised to 8, no leave reserve of Inspectors being provided. This latter plan has been adopted in the statements. This arrangement would provide for 70 posts of English-educated Veterinary Assistants of the superior service. Now as has been shown above we have at the present time seven Inspectors, *plus* two reserve Assistants acting as Inspectors of inoculators in Ranchi and two under training and 64 men posted as Veterinary Assistants either Stationary or Itinerant and in addition, at the Veterinary College at Belgachia, there are 23 or 24 men now taking the present three years' course of instruction who belong to Bihar and Orissa and have to be provided with posts. I have shown above that we require as Veterinary Assistants in charge of subdivisions and Inspectors in charge of districts 91 men in all, whereas we have at present 68 Veterinary Assistants, *plus* seven Inspectors, *i.e.*, 75 men employed and in addition 23 men under training at Belgachia, regarding whom it is uncertain whether they will all ultimately complete their education and be eligible for appointment to Government service 75+44=119 men, so that there is no great difficulty in adapting the suggested new scheme to the present number of men actually employed together with the young recruits under training.

5. In addition I desire to refer again to a matter which was mentioned in my letter of November 1913 on the subject of the reorganisation of the Department. The Native States lying in Bihar and Orissa cover an area of 28,648 square miles with six towns and 20,274 villages and a population of just under 4,000,000 people. Of these 26 States 9 are over 1,000 square miles in area, while Mayurbhanj (over 4,000 square miles) is of the size of a large British district. Four more, Keonjhar (3,096), Patna (2,399), Kalahandi (3,745) and Gangpur (2,492) are of the area of smaller or average British districts, while Dhenkanal (1,463), Baud (1,264), Bamra (1,988) and Bonai (1,296) are of the size of large subdivisions. The remaining States run from an area of 46 square miles (Tigiria), 730 square miles (Athmallik), 833 square miles (Rairakhol), and 906 square miles (Sonepur). About these States I know nothing at all, except in the case of Mayurbhanj, the Superintendent of which State I have recently had the opportunity of meeting, and I am not aware to what extent it is feasible to provide veterinary assistance. Nevertheless judging by the case of Mayurbhanj, and arguing on general principles, it seems to be clear that the veterinary organisation of Bihar and Orissa will remain incomplete and defective, unless steps are taken to control cattle-disease within these States as well as within British territory, for the States will form the *foci* of disease, which will be carried into British territory in the course of the regular export of cattle from the Garhjats to the plains of Orissa, to Bengal and Calcutta, and will nullify or at least render very difficult our endeavours to get the upper hand of cattle epidemics. This is a matter which should be referred to the Political Agent for his consideration. I mention here what I learnt from Mr. Phillip with regard to the state of affairs in Mayurbhanj. The area of the State is 4,243 square miles, which is subdivided into a *sadr* and three other subdivisions. Mr. Phillip informed me that the State has at present one Veterinary Assistant stationed at Baripada who occasionally tours into the interior. The veterinary organisation approved for a British district of the same size under the present sanctioned scale would consist of not less than four stationary and four itinerant men, although certainly a better organisation would be the provision of eight Itinerant Veterinary Assistants, because Baripada, the capital of the State which is classified as a town, has a population of no more than 5,968, the headquarters of the subdivisions being also merely villages. Mr. Phillip at the same time informed me that cattle were then actually dying in large numbers and that he was quite unable with a single Veterinary Assistant to do anything to mitigate the losses incurred by the people. So far as I am aware in the remaining 24,000 square miles of the Orissa Feudatory States, there is no veterinary aid of any kind apart from the local cow doctors, *i.e.*, either *Goalas* or *Hajams*, *i.e.*, barbers, who act both as doctors and as veterinary surgeons in the interior. If this situation is allowed to persist, these territories will be a continual menace to the neighbouring British districts, where we hope ultimately to succeed in eliminating or controlling cattle-disease. These facts are mentioned to show that a further cadre of Inspectors and superior and inferior service Veterinary Assistants working under the Political Agent of the Orissa Feudatory States will, if my opinion is accepted, be ultimately required. It is, therefore, clear that there is no danger of our being unable to provide employment for the English-educated Veterinary Assistants who are already employed or now under training at Belgachia.

NUMBER OF STAFF REQUIRED.

6. I estimate that to meet the needs of this province the following district staff will be required :—

—	British Territory	States	Total
1	2	3	4
1. Vernacular Veterinary Assistants (V. V. A.) (2 years' training)	208	28	236
2. English-educated Veterinary Assistants (E. V. A.) (4 years' training)	70	12	82
3. Veterinary Inspectors	21	5	26
4. Deputy Superintendents	5	1	6
5. Divisional Superintendents (Europeans)	5	1	6
6. Superintendent for a Veterinary School or College	1	..	1
7. Indian Professors of the status of Deputy Superintendents	4	..	4

The pay proposed for the different classes of officers would be as follows :—

Vernacular Veterinary Assistants. Rupees 12, 14, 16, 18, 20 by quinquennial increments of Rs. 2 with a proportion of the cadre limited to 10 per cent. on a special pay Rs. 25. Promotion to this grade should be both by seniority and merit.

English-educated Veterinary Assistants. Rupees 50, 60, 70, 80, 90 by quinquennial increments of Rs. 10, with a 10 per cent proportion of the cadre, on Rs. 100. Promotion to this grade should again be conditioned by seniority and merit.

Veterinary Inspectors. Rupees 110, 130, 150, 170, 190 by quinquennial increments of Rs. 20, with a special grade restricted to 10 per cent. of the cadre on Rs. 210.

Deputy Superintendents who will ordinarily be promoted Inspectors on the same scale as the present accepted scale for Assistant Professors and Indian subordinates of the Agricultural Department, *i.e.*, Rs. 250—10—400.

European Divisional Superintendents. The scale of pay and terms of service recommended in my note submitted to Government for the consideration of the Public Service Commission, *i.e.*, Rs. 500—40—1,100 in the first 15 years of service, Rs. 1,100 from the beginning of the 16th year to the end of the 20th year, rising to Rs. 1,300 at the beginning of the 21st year of service and from the 22nd to the 25th year (after which pension should accrue) there should be a further selection scale on Rs. 1,500 for which 10 per cent. of the officers in India should be eligible.

Superintendent for the School or College. The same scale of pay *plus* a Principal's College allowance of Rs. 200 per mensem.

The question whether a special Chief Superintendent should ultimately be appointed for the general control of the Veterinary Department, at present under the Director of Agriculture, may be reserved for later decision when the Department is reaching its full development. With regard to the whole of these officers I suggest that their pay might be debited in equal moieties to Government and to District Boards or Municipalities, as is the case with the present Itinerant Veterinary Assistants. Deputy Superintendents and Superintendents might be paid by Government alone, but there would be no difficulty in debiting half their pay to the District Boards in the division in which they serve, the respective debits being calculated according to the income of each Board. In all cases these Veterinary Officers should as at present be whole-time Government servants lent to District Boards and Municipalities, a calculation being made to show the contribution required from District Boards for each class of officer. It is not proposed to maintain in any way the present distinction between Stationary and Itinerant Veterinary Assistants. Stationary posts in the larger towns will be the plums of the Department for the Vernacular Veterinary Assistants, and good work can be rewarded by posting the better men to the town posts. This is not at present the case, since although a Veterinary Assistant with approved service is required at, and is generally posted to, a dispensary in a large town, while escaping the hardship of constant touring, he is mulcted of the personal allowance and fixed travelling allowance received by the Itinerant Veterinary Assistant as some compensation for his wandering existence. He may gain in comfort and even acquire a small private practice, but he loses under the proposed reorganisation scheme to the extent of Rs. 20 per mensem, a sum considerably in excess of what he is likely to make regularly in private practice.

Finally, the superior and the inferior veterinary services should not be considered as totally distinct, but on occasion, should a really smart Vernacular Veterinary Assistant be found clever at his profession and energetic enough to educate himself fairly in English, he should be allowed to return for two years to college to qualify himself for a post in the superior service.

7. *Reasons adduced in support of the strength of the proposed cadre of Vernacular Veterinary Assistants.* In fixing the number of Vernacular Veterinary Assistants required for the adequate control of cattle-disease, for the propagation of ideas on the subject of cattle-breeding and selection therefor and for milk supply, the organisation of milk record societies and the many other objects to be attained by a reformed Veterinary Department the standard taken for Municipal areas is that one Veterinary Assistant is required for all towns of a population over 17,000 (*vide* Imperial Table IV, page 14 of the recent Census Report).

For rural areas in North and South Bihar and for Orissa, except Sambalpur, mostly thanas have been taken as units (*vide* Provincial Table I, page 264 of the Census Report), but figures of population, area and agricultural stock have also been considered. In Chota Nagpur, the Santal Parganas, Sambalpur and Angul, which are extensive and at the same time sparsely populated areas, it is impossible without overburdening the local bodies to hold to the thanas as units. I have therefore for these tracts fixed a much higher standard of area for Vernacular Veterinary Assistants. Generally speaking, in Chota Nagpur the area allotted to each Veterinary Assistant approximates to 750 square miles with a population of roughly 200,000 people, but in some cases the area reaches about 1,000 square miles. In Bihar and in Orissa the area is naturally very much smaller and the population often much greater. In addition the figures of cadre for Vernacular Veterinary Assistants, English-educated Veterinary Assistants and Inspectors as shown in the table at the beginning of paragraph 6 above, include an estimate of the staff required for the Orissa and the Chota Nagpur States about which I have no definite information. I have nevertheless ventured to suggest in their case one Vernacular Veterinary Assistant per thousand square miles and a proportion of English educated Veterinary Assistants and Inspectors similar to that proposed for British territories.

The cadre for Vernacular Veterinary Assistants and English-educated Veterinary Assistants includes a 10 per cent. leave reserve and that for English-educated Veterinary Assistants includes in addition a similar reserve for the Inspectors, no reserve Inspectors being provided.

8. *Travelling allowance.* Deputy Superintendents should receive travelling allowance at second class rates under the Civil Service Regulations. Inspectors should receive travelling allowance under the Civil Service Regulations at the appropriate rates, unless it is held that this rule should apply only to journeys beyond their jurisdiction, *i.e.*, beyond the district to which they are posted. I incline to this view and would recommend that in lieu of travelling allowance for journeys within their district they should be granted a fixed monthly travelling allowance without regard to whether journeys have been made by rail, steamer or road, and also without regard to the question whether the officers have been any given number of days on tour during the month or not. It may be left to the supervising officers who will scrutinize the tour diaries of the Inspectors to check any tendency on the part of an Inspector to spend his time at headquarters instead of on tour. There should also be a rule that, in case any such tendency were observed in any officer, it should be open to the Divisional Superintendent, with the approval of the supreme controlling officer of the Department, to reduce or withhold altogether the fixed travelling allowance of any Inspector who was found persistently to neglect his duty. As a consolidated travelling allowance for this class of officer the sum of Rs. 30 per mensem would suffice. It will be remembered that this is in accordance with the recent suggestion of the Government of India that this principle should be applied to officers of all Departments and in the case of the Veterinary Department its adoption will abolish an enormous amount of office work involved in preparing travelling allowance bills and in checking and passing them in the Superintendent's office and subsequently in re-checking and finally passing or objecting to bills in the Central Audit office of the Accountant-General. There is no doubt that this reform would be of great value since it would free the Divisional Superintendents of much routine work and enable them to attend to what is properly their profession.

English-educated Veterinary Assistants in charge of subdivisions. For this class of officers I propose a consolidated travelling allowance of Rs. 25 on the same conditions as in the case of Inspectors in charge of districts and finally for Vernacular Veterinary Assistants a monthly travelling allowance or bicycle allowance of Rs. 5 upon the same conditions and with the same restrictions as before. All classes of men will be expected to keep a bicycle and the Vernacular Veterinary Assistants should be assisted to purchase a sound machine of standard quality by a system of advances similar to that in use at present for the purchase of motor-cars and motor-cycles. The other officers can probably do without such aid.

In the case of all officers, journeys beyond jurisdiction, *e.g.*, for concentration to deal with epidemic outbreaks of disease, should be dealt with under the Civil Service Regulations.

9. *Office and other accommodation.* This should be provided for in the District Board offices by the District Boards employing Inspectors and English-educated Veterinary Assistants. Very little will be needed; an extra chair, a table and an almirah in any convenient room of the District Board and Local Board offices will meet the

situation. Vernacular Veterinary Assistants will require no office accommodation, but will write up their tour diaries and epidemic and other reports and returns in the quarters they may be able to secure for themselves. Officers should provide house accommodation for themselves, as in the meantime it is undesirable to burden local bodies with the cost of the construction of a number of petty quarters for subordinate officials. These remarks do not apply to European Superintendents and to Deputy Superintendents for whom in due course, as the money can be spared, accommodation should be provided by Government at the headquarters of the divisions to which they are attached.

10. *Financial effect.* The tables given for the Punjab, Burma, Central Provinces, United Provinces and Bihar and Orissa in paragraph 2 above, show that the Punjab with over 14,000,000 less population and only two-thirds of the cattle of Bihar and Orissa is spending Rs. 5,10,935 against our Rs. 59,000 for we obtain an assignment from Imperial for the cost of our solitary Superintendent. They have four men to our one. On the same scale we should have, as is suggested, six men and possibly seven. The Central Provinces have only 50 per cent. of the cattle in Bihar and Orissa and a population of 16 millions as against our 38½ millions, but are spending approximately three times as much on veterinary relief. They have two men *plus* one on training and on the same scale again we should have six or seven men. The figures for the United Provinces are probably wrong and in any case the backward provinces should not form the example.

The income of District Boards—excluding Angul, the Santal Parganas and Singhbhum, where none exist but only road cess and other funds which, according to the present state of the law, cannot be legally spent on veterinary relief—rose from Rs. 49,98,953 in 1912-13 to Rs. 84,53,466 in 1913-14. In the former year the income from police (pounds) was Rs. 2,18,968, equal to 4·4 per cent. of the total income. Expenditure on maintenance of pounds was ·03 only. Expenditure on veterinary relief amounted to only ·97 of total income. Total expenditure on pounds and veterinary relief was then 1·00 per cent. of total expenditure against 4·4 per cent. of total income realised from cattle. It may be argued, on the analogy of the expenditure of cess drawn from special areas or industries within the areas in which those industries operate, that veterinary expenditure should equal income from cattle and the above figures show how far this is from being the case. Even if the scheme exhibited in Statement I, under which District Boards would contribute in proportion to income for all officers, were accepted, the percentage of suggested expenditure amounts to only 2·38 of income, and this figure is exaggerated owing to absence of figures of income for the three districts above-mentioned. Under the alternative suggestion, by which Government would continue to supply at its own expense the superior inspecting and administrative staff, the percentage drops to 1·28 of income, which is very little indeed—and again as explained this is an exaggerated figure on account of the Santal Parganas, Angul and Singhbhum. There can thus be no reason for the Boards to hold back from the scheme on the score of the imposition of an excessive burden on them, since the percentage figures show that this would not be the case even allowing for expenditure on contingencies, drugs, kit-boxes, serum, instruments, etc.

11. *Veterinary Education.* It is obvious that if this scheme or something of the same nature be ultimately adopted, it will be necessary for the Government of Bihar and Orissa to organise a Veterinary School or College in which the Vernacular Veterinary Assistants can be trained on a carefully thought-out curriculum, which should pay more attention to the diseases of bovines than the diseases of equines and other animals. The English-educated Veterinary Assistants would receive a full and complete veterinary education under a curriculum lasting for 4 years, those at present in the service who are considered to be professionally inefficient being returned to this school for a further period of training. The fact that the Government of Bihar and Orissa some time ago assented to a proposal of the Government of the United Provinces to combine with that Government in a College to be founded up-country need not hinder the abandonment by the Local Government of that project since in the first place Government asked for only six places in the new College in the United Provinces, intending that candidates from Orissa should continue to be educated at Belgachia. The expansion of the department in the United Provinces will in all probability easily account for the six places in question. Further, owing to the war, it is unlikely that the project of the United Provinces Government has advanced at all or that any buildings have been constructed or will be constructed for some time. The reasons in support of the proposal to have a Veterinary College of our own have been frequently placed before Government or at least alluded to in correspondence and reports, and these reasons are very cogent. The situation as regards education is changed inasmuch as an entirely new and larger scheme has now been put forward for consideration and we require curricula carefully adapted to the two classes of men it is proposed to recruit, which curricula might not be attainable in colleges or schools belonging to other Governments. If, and when it is necessary after the conclusion of the war, a complete scheme can be put forward for the organisation of the school or college required. Major Smith, Principal of the Bengal Veterinary College at Belgachia, assures me that he can at once provide two competent Biharis as Assistant Professors. If he is asked to train some more men for such posts he will be in a position to provide a complete staff either from men now at the College or by selection and training of men at present serving in Bihar and Orissa as Inspectors or Veterinary Assistants.

The proposal to train Oriyas in Hindi which would be the vernacular of the Provincial School need give no trouble. The system is already working satisfactorily at Sabour, where four short-course Oriya boys, two Muhammadans and two Hindus, are now being taught in Hindi and are found to understand the language sufficiently well to give little or no difficulty to their teachers. It has been suggested to me that we should have Veterinary Schools under Superintendents at Patna, Muzaffarpur and Cuttack and give scholarships. The schools would be under Superintendents with a specially selected Deputy Superintendent in charge. This is a matter for discussion. Myself I think that more efficient teaching would be undoubtedly secured in a large central College since owing to their constant absence on tour the Superintendents would be unable efficiently to supervise the work of the Indian Professor (Deputy Superintendent).

12. *Proposals for the year* 1915-16. I do not suggest that this scheme can be brought into force immediately or that the present occasion is ripe for any thing more than discussion or consideration, on account of the financial confusion caused by the outbreak of war. Nevertheless, I would propose with the assent of Government—and this is a suggestion made by Major Smith of Belgachia and one which I am very willing to adopt—that, say, 10 boys of the castes indicated should be selected during this cold weather and posted as apprentices, to carefully chosen Veterinary Assistants, who will be instructed to teach them their profession and employ them as their assistants in every way possible. These probationers or rather apprentices would be kept for 12 months, working partly in the muffassil and partly in a dispensary and at the end of that period would be sent for a course of two years' systematic training to a school, which can easily be organised at Sabour. This would necessitate the construction of a Veterinary Hospital on the outskirts of the Sabour Estate, in order that the local cultivators might have an opportunity of bringing their sick cattle to the hospital for treatment. It would also involve the construction of a standing camp in the Bhagalpur town so that during the six months from October to March the Veterinary Assistants under training might have an opportunity of seeing a large number of cases which could be obtained in Bhagalpur. This scheme would not be expensive during the year 1915-16 as the boys would be allowed only a subsistence allowance while under training, that is to say, sufficient to cover the cost of living away from home with a very little over by way of pocket-money. They would also get small allowances when sent on tour with an Itinerant Veterinary Assistant.

STATEMENT I.

***Statement** showing the Cost of the Scheme for the Reorganization of the Veterinary Department, Bihar and Orissa, on the assumption that Local Bodies and the Orissa Feudatory States pay half the cost of all officers.*

No.	Designation	Average pay	Other charges: Contribution for pension and leave allowance at $\frac{1}{16}$th of average pay for officers for European service and $\frac{1}{4}$th for other officers	Other charges: Fixed travelling allowance for other allowances	Total	Amount of monthly contribution payable by Local Bodies or States for each officer	Monthly cost to Government for each officer	Total annual cost to Local Bodies or States	Total annual cost to Government	Remarks
1	2	3	4	5	6	7	8	9	10	11
	BRITISH TERRITORY.									
	Imperial Service.	Rs. A. P.	Rs. A. P.	Rs.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	
5	**Superintendents**	1,056 0 0	330 0 0	2,000 a year	1,552 10 8	776 5 4	611 5 4	46,580 0 0	36,680 0 0	
1	**Superintendent for the school or Veterinary College**	1,056 0 0	330 0 0	200 (local allowance)	1,586 0 0	793 0 0	628 0 0	*9,516 0 0	7,536 0 0	
	Provincial Service.									
5	**Deputy Superintendents**	333 5 4	83 5 4	1,000 a year	500 0 0	250 0 0	208 5 4	15,000 0 0	12,500 0 0	
4	**Indian Professors**	333 5 4	83 5 4	....	416 10 8	208 5 4	166 10 8	10,000 0 0	8,000 0 0	
	Subordinate Service.									
	Veterinary Inspectors	156 0 0	39 0 0	30 (fixed travelling allowance).	225 0 0	112 8 0	93 0 0	28,350 0 0	23,436 0 0	
62	**English-knowing Veterinary Assistants**	78 0 0	18 4 0	25 (Ditto)	116 4 0	58 2 0	49 0 0	43,246 0 0	36,456 0 0	
8	**(Reserve) Ditto ditto**	78 0 0	18 4 0	....	91 4 0	45 10 0	36 8 0	*4,380 0 0	3,504 0 0	The sums marked * will be charged to the Local Bodies in proportion to their income.
189	**Vernacular Veterinary Assistants**	16 14 5	4 3 7	5 (fixed travelling allowance).	26 2 0	13 1 0	10 15 3	29,625 12 0	24,841 11 0	
19	**(Reserve) Ditto**	16 14 5	4 3 7	....	21 2 0	10 9 0	8 7 3	*2,408 4 0	1,927 5 0	
	TOTAL	....	....	....	....	....	....	1,89,105 0 0	1,54,881 0 0	
	Contingencies, Establishment, etc.	....	....	....	25,284 0 0	....	....	12,642 0 0	12,642 0 0	
							Total cost for British Territory.	2,01,747 0 0	1,67,523 0 0	The income of the District Boards in Bihar and Orissa *during* 1913-14 is Rs. 84,53,466.† Therefore the percentage cost for Veterinary Establishment is 2·38.

	ORISSA FEUDATORY STATES.									
	Imperial Service.									
1	Superintendent	1,056 0 0	380 0 0	2,000 a year	1,552 10 8	776 5 4	611 5 4	9,316 0 0	7,336 0 0	
	Provincial Service.									
1	Deputy Superintendent	333 5 4	83 5 4	1,000 Do.	500 0 0	250 0 0	208 5 4	3,000 0 0	2,500 0 0	
	Subordinate Service.									
5	Veterinary Inspectors	156 0 0	39 0 0	30 (fixed travelling allowance).	225 0 0	112 8 0	93 0 0	6,750 0 0	5,580 0 9	
12	English-knowing Veterinary Assistants	73 0 0	18 4 0	25 Ditto	116 4 0	58 2 0	49 0 0	8,370 0 0	7,056 0 0	
28	Vernacular Veterinary Assistants	16 14 6	4 3 7	5 Ditto	26 2 0	13 1 0	10 15 8	4,389 0 0	3,680 4 0	
	Contingencies, Establishment, etc.	....	....	....	....	....	....	2,228 0 0	2,228 0 0	
							Total cost for Orissa Tributary Mahals.	34,053 0 0	28,380 4 0	The income of the Feudatory States of Orissa is Rs. 40,92,132. Therefore the percentage is ·83.

* Actual cost of medicines, serum, kit-boxes, etc., cannot be accurately estimated. Ultimately cost of District Boards will probably be about 3 per cent. of income.

† The income of Local Funds in the Santal Parganas and Singhbhum during 1913-14 is Rs. 2,60,025 and Rs. 1,21,785, respectively. If these figures are added to the income of the District Boards, the percentage cost for Veterinary Establishment drops to 2·28.

STATEMENT II.

Statement showing the Cost of the Scheme for the Reorganization of the Veterinary Department, Bihar and Orissa, on the assumption that the Local Bodies pay half the cost of all officers except the Superintendents and Deputy Superintendents and the Orissa Feudatory States pay the cost of all Veterinary officers employed in those States.

No.	Designation	Average pay	Other Charges: Contribution for pension and leave allowance at $\frac{9}{40}$th of average pay for officers for European service and $\frac{1}{8}$th for other officers	Other Charges: Fixed travelling allowance or other allowances	Total	Amount of monthly contribution payable by Local Bodies or States for each officer	Monthly cost to Government for each officer	Total annual cost to Local Bodies or States	Total annual cost to Government	Remarks
1	2	3	4	5	6	7	8	9	10	11
	BRITISH TERRITORY.	Rs. A. P.	Rs. A. P.	Rs.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	
	Imperial Service.									
5	Superintendents	1,056 0 0	....	2,000 a year	1,222 10 8	....	1,222 10 8	....	73,360 0 0	
1	Superintendent for the School or Veterinary College	1,056 0 0	....	200 (local allowance)	1,256 0 0	....	1,256 0 0	....	15,072 0 0	
	Provincial Service.									
5	Deputy Superintendents	333 5 4	....	1,000 a year	416 10 8	....	416 10 8	....	25,000 0 0	
4	Indian Professors	333 5 4	....	....	333 5 4	....	333 5 4	....	16,000 0 0	
	Subordinate Service.									
21	Veterinary Inspectors	156 0 0	39 0 0	30 (fixed travelling allowance).	225 0 0	112 8 0	93 0 0	28,350 0 0	23,436 0 0	
62	English-knowing Veterinary Assistants	73 0 0	18 4 0	25 Ditto	116 4 0	58 2 0	49 0 0	43,245 0 0	36,456 0 0	
8	Reserve Veterinary Assistants	73 0 0	18 4 0	....	91 4 0	45 10 0	36 8 0	4,380 0 0*	3,504 0 0	The sums marked* will be charged to the Local Bodies in proportion to their income.
189	Vernacular Veterinary Assistants	16 14 5	4 3 7	5 (fixed travelling allowance).	26 2 0	13 1 0	16 15 3	29,625 12 0	24,841 11 0	
19	(Reserve) Vernacular Veterinary Assistants	16 14 5	4 3 7	....	21 2 0	10 9 0	8 7 3	2,408 4 0*	1,927 5 0	
							Total cost for British Territory	1,08,009 0 0	2,19,597 0 0	
	Contingencies, Establishment, etc.	....	....	....	....	....	....	....	25,284 0 0	
							TOTAL	....	2,44,881 0 0	The income of the District Boards in Bihar and Orissa during the year 1913-14 is Rs. 84,53,466.† Therefore the percentage of cost for Veterinary Establishment is 1·28.

	ORISSA FEUDATORY STATES.									
	Imperial Service.									
1	Superintendent	1,056 0 0	330 0 0	2,000 a year	1,552 10 8	1,552 10 8	....	18,632 0 0		
	Provincial Service.									
1	Deputy Superintendent	333 5 4	83 5 4	1,000 Ditto	500 0 0	500 0 0	....	6,000 0 0		
	Subordinate Service.									
5	Veterinary Inspectors	156 0 0	39 0 0	30 (fixed travelling allowance).	225 0 0	225 0 0	....	13,500 0 0		
12	English-knowing Veterinary Assistants	73 0 0	18 4 0	25 Ditto	116 4 0	116 4 0	....	16,740 0 0		
28	Vernacular Veterinary Assistants	16 14 5	4 3 7	5 Ditto	26 2 0	26 2 0	....	8,778 0 0		
	Contingencies, Establishment, etc.	....	....	....	....	....	....	4,456 0 0		
							Total Orissa Feudatory States	63,106 0 0	....	The income of the Feudatory States of Orissa is Rs. 40,92,132. Therefore the percentage of cost is 1·66.

† The income of local funds in the Santal Par[illegible]nas and Singhbhum during 1913-14 is Rs. 2,60,025 and Rs. 1,21,785, respectively. If these figures are added to the income of the District Boards, the perc[illegible]ntage cost for Veterinary Establishment drops to [illegible]·28

APPENDIX C.

Subject VIII.—Notes on the Co-operative movement in its relation to Agriculture.

(1)

(B. C. BURT, B.Sc., *Deputy Director of Agriculture, Central Circle, United Provinces.*)

Of the importance of the development of close relations between the agricultural departments and the co-operative movement there is not the slightest doubt. In the United Provinces the co-operative societies represent practically the only *cultivators'* organisations possible since even the best of the agricultural associations of the past have been composed partly of *zemindars*, whose interest in actual cultivation is variable and whose interests are by no means identical with those of their cultivators, and partly of *vakils* and others, whose connection with agriculture is somewhat fortuitous. Hence in merely providing cultivators' unions, to whom the department can appeal the co-operative movement is of the greatest value.

The Agricultural Department in the United Provinces has from the beginning made an effort to keep in touch with co-operative societies and the last two or three years have marked a definite stage in the development of these relations, largely due to the growing strength of the central banks. Most advanced co-operators have realised that the benefits of co-operation are not limited to the supply of cheap capital but that the application of the capital to the best advantage is of equal importance. *If the experience of other countries is any guide, greater success is to be looked for in the application of co-operative principles to agricultural development than in the mere provision of credit* and several of the more advanced societies in the United Provinces are now taking up agricultural work of a definite nature. As an example may be mentioned the schemes which three central banks are developing for the replacement of *desi* wheat by Pusa 12, involving a seed store owned by the bank ; a circle of selected growers, from whom wheat (grown from seed of known purity) will be purchased for supply to other members ; and arrangements for purchase, inspection and distribution. At present the fields are inspected and the seed passed by the staff of the Agricultural Department. Two societies are also co-operating with the department in the purchase of this wheat for experimental shipment thus providing incidentally an object lesson in co-operative sale of produce.

Similar arrangements for the supply of cotton seed are also at work. Preliminary arrangements are being made with other societies also for similar work but the development of these is at present hampered by the limited quantity of pure seed which we can produce and issue.

The question at once arises whether the existing societies, which were primarily organised as credit societies, should undertake this work or whether it should be undertaken by special societies organised for the purpose. As far as the United Provinces is concerned the general opinion is that the existing organisation should be utilised. It is unlikely that separate societies with practically the same personnel would be understood by cultivators, nor does it seem to be desirable to forego the advantage of the position which the central banks have created for themselves. This does not mean, however, that special societies should not be formed where adequate reasons exist. *One such society, a co-operative seed society has recently been registered in the Central Circle, United Provinces,* the members being mainly cultivating *zemindars*.

For general purposes the unit with which the department has found it best to work is the Central Bank. The best of these have strong directorates and are in a position to raise money at favourable rates for profitable schemes ; they generally handle business matters satisfactorily. In addition to this it has been found necessary in practical matters to get into direct touch with the individual banks through the medium of personal tours and the work of agricultural assistants posted to a definite tract. Such work should, however, be carried out with the knowledge and co-operation of the central banks. In isolated instances work has been started in direct relationship with unusually good village banks, but this has not been found so satisfactory as working through the central banks. It may, however, be mentioned that the organisation of groups of village societies into central banks is not yet complete.

A certain amount of latitude is necessary in dealing with central banks in agricultural matters. It has to be borne in mind that they are unofficial organisations whose independence it is essential to foster and it is therefore often desirable to concede a point that might otherwise be insisted upon. Some of the most successful directors of central banks are not themselves agriculturists and this necessitates additional care in framing propositions for agricultural work.

A very useful method of fostering the relations between the Department and the village banks is afforded by periodical conferences. A joint agricultural co-operative conference has been held annually in one district for three years in connection with the district exhibition at which the central banks have been represented by the directors, inspectors and village societies, by the majority of the *sarpanches* concerned, and by many ordinary members. These conferences afford an excellent opportunity for the discussion of proposals for agricultural work. Similar conferences are held in other districts also and one of these was attended by the Agricultural Adviser in 1914. At the annual provincial co-operative conference officers of the department attend and contribute papers.

It is perhaps almost unnecessary to lay stress on the necessity of obtaining the registrar's advice and assistance before starting any important work with co-operative societies. The policy in the United Provinces has been for the registrar to interfere with the management of such societies as little as is compatible with proper supervision and the department uses the organisation freely in distributing information. But it is obvious that only a really sound bank can successfully undertake extensions in the direction of agricultural work, while other banks may be sound but too young to undertake anything beyond the development of their credit organisation. In this respect the registrar's advice and assistance are indispensable and in all cases his co-operation is an important asset both in encouraging the local directorate and in matters of organisation.

It is also desirable that some caution should be exercised in selecting projects in which co-operative societies are to be asked to invest money. It is true that many societies have now a small fund set aside from their profits which can be spent on agricultural development or even on experiments. Generally speaking, it is wiser not to ask them to undertake operations involving any appreciable risk until they have some experience to go on. Thus in initiating a new procedure, such as the buying in of *kapas* from members at a premium for seed supply, it was found desirable for the department to finance the transaction during the first year. When the directors of the bank saw that the operations were simple and resulted in a profit they were quite willing to undertake the responsibility in succeeding years. It cannot be too strongly emphasized that projects which the agricultural department look on as certain as the result of their more extended experience often appear in the light of experiments to the banks *and this should be borne in mind in starting new work if it involves expenditure.*

*In this connection it may not be out of place to discuss the proposal made by the Co-operative Commission that the Agricultural and Co-operative Departments should be united under one head who should be called the Development Commissioner. At first sight their proposal is somewhat attractive but detailed examination will show that while it might attain nominal collaboration between the two departments, in practice it would be attended by so many disadvantages as to be positively mischievous.

It is clear from the Commission's report that they contemplate that the officer appointed to this post would be mainly selected on account of his qualifications as a co-operative organiser. The disadvantages of interposing an additional non-technical officer between the Agricultural Department and Government do not appear to have been fully realised. The Director of Agriculture effectively barred from any direct approach to Government would no longer be head of his department except in name, and the creation of this additional post office would seriously hamper the work of the Agricultural Department. Nor would the position of the Chief Registrar of Co-operative Societies appear to be any happier.

It cannot be too strongly emphasized that collaboration between the departments cannot be secured by paper organisation—friction is far more likely to result. Technical departments require easy access to Government if they are to carry on their duties properly and anything which hampers this—however convenient from the secretariat point of view—is retrograde.

And, finally, can any possible justification be found for the diversion of funds to provide a highly paid administrative officer when the technical work of the departments concerned is hampered by want of money ?

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(2)

[G. EVANS, M.A., *Deputy Director of Agriculture, Northern Circle, Central Provinces.*]

As you are no doubt aware there has been in the last two or three years a remarkable and gratifying increase in the amount of interest taken in the efforts of the Agricultural Department and in the question of agricultural improvement generally in the Northern parts of the Central Provinces.

In my Circle there are at present more than twenty Agricultural Committees at work and nearly 100 seed farms are also inspected. These are all working separately and on more or less distinct schemes and this adds immensely to the work of the Department and tends to much confusion.

I am now in a position to suggest a regular line of work for these Committees to act on, which is based on the results of two years' working of two Agricultural Unions in the Narsinghpur District which are proving remarkably successful.

These Agricultural Unions, as they are called, control a limited and compact number of villages. They have a small farm of their own which, in the case of a wheat tract, is about 30 acres in extent. The area for this farm is acquired or leased by the Union. The Union has a capital of about Rs. 500 which is raised by means of Rs. 10 shares. Each member on joining the Union must take at least one share.

The farm is divided into two parts :—

(1) A small area of about two acres which is used for testing any new varieties the members in consultation with the Agricultural Department may wish to try.

(2) For the propagation of pure seed of the variety which has proved most successful after trial.

Fresh seed is obtained for this farm every year from the Government Farm. The produce of the Union farm is sold each year to the members. Each member reserves one field of his own for growing seed from the Union farm and reserves the produce of this field for the remaining area for next year. By this means each member is continually renewing a portion of his seed, and in two or three years the whole of his land will be sown with first class pure seed which will give him the biggest profits possible.

The Union should consist of as members either *malguzars* or good *kisans* who live not more than five or six miles from the central farm. It should have a secretary and a managing committee of three or four members who should be elected at a meeting of the full Union. The work of the managing committee is to look after the general management of the farm which will be in charge of a *Kamdar* who will be responsible to the managing committee. A simple set of accounts, showing receipts and expenditure, will have to be kept.

The Union when formed ought to be registered as a Co-operative Union by the Registrar, Co-operative Societies, as the following benefits will result :—

(1) The accounts will be properly audited.

(2) A proper Reserve fund will have to be kept, so that provision may be made for—

(*a*) Partial failure of crops.

(*b*) Renewal of bullocks and stock.

(*c*) Extra contingencies.

This is being done now by the Gotegaon and Chanwarpatha Unions of Narsinghpur District and results attained so far are most gratifying. Nearly every village within a radius of four miles of the Union farm has at least one member, and many more persons are clamouring to join.

A Union of this sort affords not only a means of introducing new varieties to a large area but also affords a means of demonstrating new methods of cultivation.

This scheme is applicable to other crops such as *dhan*, cotton, etc., and not only to wheat. They have the great advantage that every member has a personal interest in the success or failure of the Union as if the farm makes large profits he gets an increased dividend and *vice versâ*.

The small committees and associations at present existing are no doubt doing good work but would do far better if every member was personally responsible for their success or failure and it is in this respect that these new Unions afford the brightest prospects for the future.

By-laws for Co-operative Agricultural Unions.

1. This Agricultural Union shall be called . . . . . . Agricultural Union, Ltd.

2. It is registered under the Co-operative Societies Act II of 1912 with registered headquarters at. . . . .

3. The particular objects of . . . . . . Union are :—

4. The membership of the Union shall be open to *bonâ fide* agriculturists residing within the limits of the area controlled by the Union which are defined as follows :—

5. Persons wishing to join the Union may be admitted by the Managing Committee, and each member on joining must take at least one share.

6. No member shall withdraw from the Union without the permission of the Managing Committee, but once it has been decided to strike off a member his share shall be sold and the amount realised shall be refunded ; if, however, the member is being rejected for any misbehaviour towards the Union, the General Assembly shall have powers to confiscate either the whole or part of the share money. Existing members shall have preference in purchasing the available shares.

7. The General Assembly shall meet at least twice a year in order to conduct the work of the Union. The following matters must be dealt with by the General Assembly :—

(a) To elect a managing committee of . . . . . . members.

(b) To discuss and pass the annual report before submission to the Registrar.

(c) Repeal or amendment of the existing by-laws.

(d) Expulsion or election of members.

(e) The settlement of programme for the next year, examination of annual accounts and disposal of the profits.

8. The appointment of a President and Secretary shall be made by votes in the General Assembly and in consultation with the Deputy Director of Agriculture and shall receive the sanction of the Registrar, Co-operative Societies.

9. The President shall see that the work of the Union is carried on efficiently and in accordance with these by-laws.

10. The *quorum* necessary for a General Assembly shall be half and every member present shall have only one vote.

11. All matters shall be decided by a majority of votes of the members present. In cases of equality of votes the motion shall be considered to be lost.

12. No change in the by-laws shall be made without the previous sanction of the Registrar.

13. Within a month of the closing of the co-operative year ending June 30, the Managing Committee shall prepare a statement showing receipts and expenditure during the past year and another showing the assets and liabilities of the Union on the last day of the year.

14. The Managing Committee shall consist of five members duly elected in a General Assembly and shall consist of President, Vice-President, Secretary and two other members.

15. It shall be the duty of the Secretary to maintain the accounts of the Union and carry out the resolutions of the Managing Committee.

16. The Managing Committee shall have the following powers and duties :—

(a) To spend the funds voted in the General Assembly for the up-keep of the farm in a manner deemed best to maintain the efficiency of the farm.

(b) To arrange for supply of seed from the Government Farm to the Union Farm and from the Union Farm to the individual members.

(c) To supervise the work of the Union *kamdar* or any other servant of the Union.

17. The Union may borrow money from time to time only in such a manner or in such amounts as may be approved by the Registrar whose sanction shall be obtained for every loan taken.

18. The Managing Committee shall be bound to observe such rules for particular work as may be prescribed by the Deputy Director of Agriculture from time to time. Such rules shall be forwarded to the Registrar as an integral part of the by-laws for registration.

19. The Union shall maintain such books and registers as may be prescribed by the Registrar and the Deputy Director of Agriculture.

20. The President and the Deputy Director shall have power to call a general meeting of members whenever necessary.

21. The books and accounts of the Union shall be open at all times to inspection by the Registrar or Deputy Director or any member of their staff.

22. The Deputy Director of Agriculture shall exercise powers of general control over the agricultural affairs of the Union and the Registrar shall have powers to dissolve the Union if he considers it necessary or expedient to do so.

23. The profits of the Union shall be utilized as follows :—

1. Not less than 25 per cent. for Reserve fund.
2. Subscription to pay for the cost of audit (Re. 1 per head per member per annum).
3. Dividends which should be limited to 6 per cent.
4. For capital expenditure.

24. The liability of the member is limited to the full value of the shares purchased or promised to be purchased by him.

25. The resolutions passed by all meetings shall be recorded in a minute book to be signed by the Secretary and the President in token of accuracy and a copy shall be sent through the Central Bank to the Registrar.

26. The instructions of the Agricultural Department shall be recorded in an inspection book kept for the purpose.

Rules for the Guidance of Gotegaon Agricultural Union.

1. The Union shall have a Central farm of . . . . acres which shall be equipped from the funds subscribed by shareholders.

2. A small area shall be devoted to testing new varieties of wheat from the Government Farm. The remaining area shall be cropped with the variety of wheat which has given the most satisfactory results in the past.

3. Fresh seed for the Union farm shall be obtained from the Government Farm each year for the whole area.

4. The whole of the produce of the Union farm shall be disposed of to individual members who will maintain their own seed farms.

5. Each member shall select a certain field for his seed farm and shall sow this field with fresh seed from the Union farm seed each year.

6. A register shall be kept by the Union Committee of the name and area of the seed farm of each individual member and of the quantity of seed he requires each year.

7. Each member should thresh and winnow the crop from his seed farm separately and keep the produce for sowing on a larger area next year.

8. Each member must sow only one variety of wheat in the field he selects for his seed farm.

9. All *teora* should be uprooted while green and removed as the presence of *teora* in wheat samples lowers its market value very much.

APPENDIX D.

Subject X.—Notes on Sugar Industry.

(1)

BENGAL.

[H. E. Annett, B.Sc., F.I.C.]

Agricultural Aspect.

(a) *The survey and testing of local varieties under chemical control.*

This work was begun at Dacca in 1913. In accordance with instructions, the Divisional Agricultural Supervisors have sent to the Dacca Farm a number of varieties of canes found in their divisions. It is hoped to obtain in this way a complete collection of Bengal cane varieties. In order that this work may develop properly a special man will be required to superintend the work. It is hoped that sanction may be obtained for this and also for a small area to test the various varieties. The Fibre Expert proposes to take over a small area for his jute work, and the cane experiments might very well be done on the same area.

In 1914-15, fourteen varieties of Bengal canes were grown at Dacca. These were again grown in 1915-16 and were recently analysed.

In 1915 canes purporting to be of 44 other varieties from various parts of Bengal were added to the collection. A few of these arrived obviously wrongly labelled. These varieties have all been harvested, and 800 cuttings of each of these and of the varieties which have been grown for two years on the farm are to be sown this season. An endeavour will be made to examine all these canes chemically and botanically.

In 1914-15, seven varieties were tested in the Rajshahi Farm, *viz.*:—

1. Vendamakhi.
2. Dacca Gadheri.
3. Shamshara.
4. Striped Tanna.
5. Yellow Tanna.
6. B.-147.
7. Khagri.

The indications were that Vandamakhi and B.-147 were superior to the others. In 1914-15 White Tanna proved much superior to the Khari at the Burdwan Farm.

(b) *In testing such imported varieties as appear* primâ facie *suitable.*

We have been experimenting with the following five varieties of sugar cane on the Dacca Farm, (1) Dacca Ganderi. (2) Yellow Tanna, (3) Striped Tanna, (4) B.-147 and (5) B.-208. Up to date B.-147 is the most promising of these. It has a richer juice and yields far more heavily than the local Ganderi. But being a hard cane it is not suitable for chewing purposes. B.-208, as reported last year, has the highest percentage of sugar in the juice, but it is rather too soft and too delicate for Dacca. It requires to be fenced in order to keep out pigs and jackals. Yellow Tanna, though not very rich, is very hardy and a good yielder. Striped Tanna is a thick cane with a luxuriant growth; but it has been discarded from the present year's experiments on account of the impurity of its juice and the difficulty of crushing it. In its place a thin cane, called Sarethi of Aligarh, was substituted and did extremely well.

Ratoon canes of all the five varieties were grown from the previous year's plant canes; but they were badly attacked both by red rot and the stem-borer.

Several other varieties are also under examination, namely, (1) Red Mauritius, and (2) Barbadoes 3, 412, both of which have done well in Southern India, (3) Java from Coimbatore, (4) Java No. 247 also from Coimbatore, (5) Java No. 36 from the Central Provinces, (6) Java No. 33 from the United Provinces, and (7) Sunnabili from the Central Provinces.

(c) *The distribution of the best varieties so determined.*

The demand for good sugarcane cuttings exceeded the supply even before the outbreak of the war. The area under sugarcane of the best varieties on our existing farms has, therefore, been extended as far as possible, and the production of cuttings in private seed farms is being arranged for.

(d) *Demonstration of improved mechanical methods.*

Work under this head has so far been confined to the demonstration of the iron roller cane-crushing mill and shallow evaporating pans. The iron roller cane-crushing mill has generally supplanted the wooden roller: but the shallow evaporating pan has not been accepted to any great extent.

An apparatus has been imported from the United States of America for producing *gur* from date palm juice by an improved method.

(e) *The study of questions of tillage, watering, manuring and draining, so as to increase the average outturn per acre.*

As regards tillage, steps are being taken to demonstrate the advantage of ridge and furrow system, especially in places where irrigation is possible. As regards manuring, steps are being taken to demonstrate the advantage of castor cake as a manure for sugarcane in combination with cowdung. Liming is being tried on laterite soil and phosphates in Rajshahi. As regards the question of irrigation, watering is necessary for sugarcane mainly in Western Bengal and in the laterite soil of Northern and Eastern Bengal from November to April. Experiments are being tried in the Dacca and Burdwan Farms in this connection. An experiment is being made in the Dacca Farm to see whether any advantage will be gained by running off water from the soil.

Progress in Palm Sugar Investigations.

Definite progress has been made in this work but only the barest outline can here be set forth, since the result are the outcome of work which has been carried out during this cold weather and numerous analyses and calculations have yet to be made in order to complete the work.

The Bengal Government allotted a sum of Rs. 1,750 for this work, and a large proportion of this amount was spent in the purchase of an up-to-date maple sugar-making outfit from United States of America. This plant has been worked throughout the past cold weather and has not, on the whole, worked very satisfactorily. At times its evaporating powers have been found to be very high, but uniform results could not be obtained from it at all times. The furnace, however, is certainly a good one and caused some saving in fuel consumption.

One thing established, however, was the fact that the use of making metal pans was not the solution of the difficulty of producing a lighter coloured *gur*. As a result of experiments in 1892-93 in Bengal this had been stated to be the solution of the problem.

In general the following results have been attained :—

1. *A saving in cost of fuel in* gur *making.*

A very large number of experiments have shown that 2·3 maunds of coal or 7·9 maunds of wood fuel are required to produce one maund of *gur*.

Coal in Jessore costs about 6 to 6½ annas per maund and, I am informed, might be sold at even less than this.

Wood costs, as far as my estimates show, not less than 4 annas per maund, and it is often difficult to obtain. Two-and-a-half maunds of coal, therefore, cost say 15 annas and 7 maunds of wood cost Rs. 1-12-0. There thus seems a considerable future for coal fuel. It is worth-while recalling that the selling price of the date *gur* is only about Rs. 4 to Rs. 4-8 per maund.

The furnaces in use have no under-draught at all and are simply holes in the ground. Hence I am at present engaged in deciding on a cheap furnace which will burn coal.

2. *Improvements in quality of* gur.

It was soon found that the use of iron pans in place of the earthenware ones, ordinarily in use, did not appreciably improve the colour of the *gur* which usually is very dark.

The colour of the *gur* has now been shown to be due to the alkalinity of the juice as the alkaline constituents of the juice produce black substances by action on the reducing sugars.

By slightly acidifying the juice a light yellow *gur* of first rate quality is obtained. The substances so far used for this have been citric acid, alum and tamarind fruit emulsion. Hydrochloric acid did not give such good results. Tamarind juice costs practically nothing and alum about 1½ anna per maund of *gur*, while the price of citric acid of course would make it prohibitive.

3. *Improvement of day juice.*

The day juice runs mostly to waste but from heavy yielding trees it is collected and boiled in the evenings to a syrup. Owing to the high glucose ratio it will not crystallise and the molasses is mixed in with the good crystallised *gur* made from night juice. By the use of lime or of formalin in the pots in the day time the juice obtained was mostly of the same quality as the night juice or approaching that quality and very good crystallised *gur* has been obtained from it.

Other work has been done in order to improve the quality of juice collected. The following summarises this work :—

(*a*) The use of metal buckets for juice collection.

(*b*) The use of lime in the pots.

(*c*) The use of formalin in the pots.

Until all my results are brought together it is not possible for me to put forward any conclusions in this connection.

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(2)

BIHAR AND ORISSA.

[Bernard Coventry, C.I.E.]

Mechanical aspect. In the matter of crushing of canes or evaporating appliances, as used by cultivators, no new work can be reported. As regards sugar factories, the Ryam Central Factory was put up last year and the Bubnowlie Factory the year before. Mr. Peter Abel noticed various defects in machinery. His opinion was that the handling of cane in the factory yards and the crushing of the mills deserve the most serious attention in Bihar. The waste of both labour and material here is enormous. Clarification is not quite satisfactoy. Some of the factories are trying to put this right.

Botanical aspect. At Sabour the collection of sugarcanes was continued in pure culture and the results have been published in the Botanical Memoir, Vol. VII, No. 2. With it an attempt has been made to classify some of the varieties of sugarcane found in Bihar.

Chemical aspect. Investigations have been made by Mr. Taylor on the potash content of the juice of sugarcane on a more extended scale. Some work on the different acids present in the cane juice is fairly well advanced.

Agricultural aspect. On the Sepaya Farm the canes planted last year have been supplemented by six varieties of canes obtained from the Director of Agriculture and Stock, Queensland. Mr. Taylor has found that in all cases in which cane is well-grown there is great risk of loss in cutting it in Bihar before the end of December. Where cane is stunted it may, however, produce a sweet juice before that date; that *Khari* and *Shakar Chinia* ripen early and that dwarf canes *Hemja, etc.*, later. While it is safe to cut *Khari* and *Shakar Chinia* in January, the dwarf canes cannot be cut with safety before the middle of February; that heavily manured canes will ripen from a fortnight to a month later than lightly manured canes; that we cannot hope by varying the date of planting to alter the date of maturity.

Assistance required. A Sugarcane Station in North Bihar. (See separate Note.)

Work already in progress to assist cane-growing. *Khari* sugarcane was grown by a few ryots in the Bhagalpur Division and gave a heavier outturn. In the Orissa Division, the cultivation of *Mungo* variety has been greatly extended in Banki and the tenants prefer it to the local variety. The demonstrations held by the Divisional Inspector on the ridge and furrow system of cultivation were much appreciated by the tenants who are planting *Mungo* canes

under that system. The yield of *gur* from this variety is superior to that from the local variety. The Demonstration Farm at Angul and the Local Association obtained fairly satisfactory results with the demonstration of *Khari* and *Mungo* sugarcanes. The *Khari* variety is also being demonstrated in Sambalpur.

Usually nearly 50% of the cane sugar present in the juice is recovered as first class sugar by Indian methods of boiling. Assuming an average of 300 maunds of cane to the acre, 180 maunds of juice are obtained from which the Bihar cultivators, by cutting their cane in November, get 9 maunds of sugar. As the result of experiments with *Khari* variety, Mr. Taylor has shown that by waiting until January they would get 11¼ maunds per acre.

Note on Sugar in North Bihar.

[BERNARD COVENTRY, C.I.E.]

At the present moment there are no less than 10 Central Factories in Bihar crushing approximately 3,000 tons of cane a day and the addition of others is in contemplation. These factories are all working during the present time at very handsome profits. But even before the war when the price of sugar had touched a very low figure the majority were working at a profit. That the price will ever be as low again as the lowest before the war is highly improbable. We are, therefore, fairly safe in concluding that the Central Factory in Bihar has a fairly bright prospect in front of it. It is the opinion of many that practically the whole of North Bihar is suitable for the growth of cane. You have only to go round the Pusa Farm and get Mr. Milligan to show you his crop of cane to be convinced of this. Pusa is by no means the most favourable type of Bihar soil for the growth of cane, but rather the reverse. But it shows what can be done in Bihar by improved cultural methods. We know that by the introduction of an improved cane and the application of improved methods of cultivation we could raise the production of sugar per acre to a very much higher figure than it stands at present. It is not too much to say that it could be easily doubled. It is, therefore, concluded that at present there is no other part of India where the prospect of successfully introducing the Central Factory system is so promising as in Bihar. It was for these reasons that the Board in 1911 passed a resolution, in which it suggested, for the consideration of the Government of Bengal (now the Government of Bihar and Orissa), that the establishment of a sugar station to the North of the Ganges is most desirable in the interests of the industry. Well, inspite of this the sugar station has not been started though the Government of India, soon after the Board of 1911, gave a grant of Rs. 50,000 towards it, and a site has been selected.

It is hoped that the Board will take note of this and again point out the great desirability there is for assisting the Central Factories in North Bihar.

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(3)

UNITED PROVINCES.

(a)

[THE HON'BLE MR. H. R. C. HAILEY, I.C.S.]

Mechanical aspect. Since the last report was presented the experimental plant for *gur* and sugar making designed by Mr. Hulme has been installed at the Nawabganj farm near Bareilly. In the first year's working the crushing mill developed certain defects which had to be remedied before a full trial could be made of the plant. The new parts have only just been received from England and cannot be installed in time for this season's working. The plant is being run for demonstration purposes, but it is not working at its full capacity and no definite results can be obtained until next season. An application has been made for the further retention of Mr. Hulme's services.

It was decided to enlarge the Philibhit factory and instal a larger crushing plant. The plant was procured from England and was put in under Mr. Hulme's supervision in time for this season's working. The factory's sugar now commands the special prices paid for Khandsari sugar, and its future prospects are favourable. The high prices of sugar have aroused some interest in the industry, and projects have been laid before Mr. Hulme which may lead to the establishment of new factories, as there is a likelihood of the continuance of satisfactory prices after the war.

(b)

[WILLIAM HULME, *Sugar Engineer Expert to the Government of India.*]

The improvement of the indigenous methods of *gur* and sugar making in the United Provinces was one of the propositions placed before me when I was appointed.

At first it seemed to be quite an easy thing to do; it appeared to be necessary only to introduce a simple and more efficient cane-crushing mill than the country bullock mill and some simple method of clarifying and concentrating the cane juice which would be better than the "bel" and "sair" systems of *rab* making and the one-pan method of making *gur* generally used in these Provinces.

After studying the proposition for several seasons, I found that any improvement in the design of the country mill would increase the cost to such an extent that the poorer cultivators would neither purchase nor hire the more expensive mill.

It is well-known to those who take an interest in the sugar industry that a very large proportion of the sugarcane grown in these Provinces is crushed by the small country made mills, which are marvellously cheap. They are designed to be rotated by a pair of bullocks such as are found locally and give an extraction of about 50%. From a broad economic point of view the low extraction given by these mills is a national calamity, but from the cultivator's point of view it is "Hobson's choice." He would like very much to get more juice from his cane, but he could not afford to buy or hire a better mill and stronger bullocks which would be necessary to get higher extraction, besides the Khandsari to whom he sells the juice objects to his taking too much out of the cane because with low extraction there is less gum and other objectionable substances which he cannot deal with in his primitive way and as the sugar left in bagasse improves its calorific value in boiling the juice, and if the extraction were higher the Khandsari would have to buy more wood.

The country mills are usually hired by co-operant cultivators and fixed up adjacent to the "bel" which is owned by the Khandsari who pays money in advance to the cultivator to insure the supply of juice during the cane crop, for which the Khandsari pays his own price which is not as a rule generous.

The "bel" contains usually five pans of the cheapest possible kind which are built up on a furnace made of mud, housed in a mud house with a roof of grass. One cannot conceive anything that would be less costly.

After the season is over the pans are taken away and the mud-house, if left standing, is often washed away during the rainy season.

Any improvement of a permanent character would probably cost twenty times the amount spent on the temporary mud-house and arrangement of pans, besides the temporary mud-house is built usually in a *tope* near to the fields where the cane is grown and not always in the same place.

Having all these things in view it becomes apparent that there is little hope of improvement in a small way.

Some of the more prosperous cultivators have adopted, and others are inclined to adopt, power-driven mills; and the kind of power most favoured seems to be the oil-engine. The oil-engine is a complicated engine, it has many parts of delicate construction and is never efficiently managed unless thoroughly understood.

It is an ideal scheme to have some kind of motive power on a farm other than bullocks, and if it were assumed that oil-engines could be worked successfully by cultivators, and that they could be used for driving sugarcane crushing mills, the question arises as to whether this combination could be made to be a commercial success; would the results obtained be likely to warrant the high initial cost and up-keep and would its general adoption be likely to reduce or even check the galloping increase in the importation of sugar recorded previous to the war? I venture to say it would not.

The extraction of juice by a three-roller mill, no matter how powerful, must be less than that obtained by a fourteen-roller mill with maceration such as now used in modern factories.

In a modern factory crushing 1,000 tons of cane per day (which is a moderate size) little or no fuel is required other than the bagasse. In the case of the oil-engine driven mill the cost of the oil would be a serious handicap. Added to this there are considerable losses due to open pan boiling, probably 15 % of the crystallisable sugar is lost by inversion and caramolization. Then there are the disadvantages of climate to consider. It is obviously essential that any sugar plant taken up must be highly efficient. If it is intended to compete with countries where all the conditions are more favourable, where the cultivation of cane is organised by experts and where the machinery adopted is the best that can be made.

The experimental works which have been erected at Nawabganj, Railway Station Bijauria, Bareilly District, were designed with the object of testing the efficiency of a plant which, in my opinion, is the smallest plant that could be worked on a commercial basis, and if reasonable profits could be assured, to place it before small capitalists. Care has been taken to make the machinery and process as simple as possible so that the super skilful management and highly technical supervision, so essential in large modern factories, would not be necessary.

In the initial stages the plant is being worked under chemical control with the view of finding out the simplest and most efficient methods of clarification of the juices, and an attempt is being made to produce crystal sugar without the aid of a vacuum pan which is so costly and requires so much skill to manipulate.

The experimental work is proceeding satisfactorily, but there is still much to be done. Some additional plant which has been delayed owing to the war has just arrived and is in course of erection, though I fear, there is little chance of testing it this season as there is very little cane available.

A brief description of the plant may be interesting :—

(1) A compact eleven-roller mill without intermediate carriers. The rollers are 10" diameter and 15" long. The cane passes through by gravitation. The sucrose extracted is about 83 % with thin canes.

(2) The juice is strained through a sieve and pumped to a sulphur box in which sulphur fumes are mixed with the juice.

(3) From the sulphur box the juice falls by gravitation into a liming tank where it is weighed and milk of lime added to neutralise the acids present.

(4) From the liming tank the juice falls by gravitation into a reservoir tank from whence it is pumped into clarifiers.

(5) The clarifiers are two in number and of the rectangular type with a copper steam coil. There the juice is quickly heated and the scum removed. It is then allowed to settle until the juice becomes clear. The clarified juice is then run into bag filters.

(6) The bag filters are two in number worked alternatively. The filtered juice runs by gravitation to a film evaporator.

(7) The film evaporator is of the "wetzel" type modernised. There the juice is concentrated without being excessively heated to a density of 40° "Beaume." The concentrated juice is now on the point of crystallization and is removed either into "Kalsis", earthenware vessels, or into a crystalliser.

(8) The crystalliser is a vessel in which slowly revolving agitators keep the massecuite in motion and bring into close contact the crystallisable particles. When the crystals are properly formed the massecuite or "rah" is put into a centrifugal machine.

(9) The centrifugal machine separates the crystals from the molasses and, after drying, the sugar is ready for market.

The molasses is again concentrated in the film evaporator and put into masonry tanks where further crystallisation takes place, after which it is put into the centrifugal machine for separation.

(10) The bagasse from the mill passes into a special bagasse burning furnace, and steam is generated in a multitubular boiler.

(11) The multitubular boiler supplies sufficient steam for all purposes.

(12) The mill engine drives the pumps, film evaporator, centrifugal machine and crystalliser, and the exhaust steam from the engine is used for heating the film evaporator.

When the cane mill is working no fuel other than the bagasse is required.

A number of analyses have been made at the factory by Mr. Sanghi, my Chemical Assistant, and may be seen here if desired.

(c)

[G. Clarke, F.I.C.]

The equipment of the Sugar Research Station, Shahjahanpur, has been completed.

The problem for this station at the moment is a purely practical one, *viz.*, to select from existing material, types of cane suitable for cultivation as field crops in the sugar tracts of the United Provinces, to replace the present inferior canes.

Canes have been collected from many sources and for examination have been divided into two groups: (1) Pounda canes, which include thick varieties mostly imported and generally *requiring special methods* of cultivation, (2) Utah canes, which include the thin indigenous varieties of Upper India.

Canes of the Pounda class have been obtained and successfully reared from the following places :—

The Cane-breeding Station, Madras	Java.
Hawaii.	Natal.
Louisiana.	Spain.
Mauritius.	Queensland.

Two varieties—a single plant culture of Ashy Mauritius (S. 11) and Java 33, have been carried on to a factory scale. Messrs. Carew & Co., Rosa, United Provinces, have interested themselves in the introduction of better class canes amongst the cultivators growing canes for their factory, and through their efforts this year these two canes were grown on a field scale and very thoroughly tested on a large scale in their factory. The results were very satisfactory, in fact exceeded our expectations.

It is not necessary to go into details which will be published later; but it may be mentioned that the juice of Java 33 contained 15 % sucrose and Ashy Mauritius 16 % sucrose, and that both canes gave 70 % of juice on dry crushing with several tons in the 9-roller mill of the factory. Indigenous canes giving under the same conditions 10-11 % sucrose in juice and 55 % juice per 100 of cane.

It has been found that Java 33, a medium cane, *is well adapted for general cultivation with very simple* and slight modifications of the country method. It has been tried at many centres in the United Provinces and in the *coming season a considerable area will be under this variety*.

The demand for seed exceeds the supply, it is being taken up both by the cultivators themselves and by the factories which finance the cane crop in their immediate neighbourhood.

Seven seedlings have been received from the Cane-breeding Station, Madras, five of these have been grown on 1.9 acre plots this year, carefully examined, and, I think, I may say, information of considerable use for this work obtained.

Work with the indigenous canes has been principally confined to the isolation of pure types from the mixtures grown in the various sugar tracts.

This work is proceeding and is being extended.

At the present time two types of cane are found to be superior to the mixtures generally grown. They are (1) Saretha, isolated by Dr. Parr, from the mixture of canes grown in the Western Districts of the United Provinces; (2) Reora, obtained from Benares. The distribution of these canes is proceeding, and there is much demand for the pure seed grown at the farms.

To encourage more intensive cultivation and the introduction of improved varieties, Government of the United Provinces has distributed free of cost *Mohwa* and castorcake meal to cultivators and *zemindars* in selected tracts.

It is hoped, by familiarising the cultivator with the value of this form of the manure, that a development of the oil crushing industry and the improvement of cane cultivation will be possible.

A grant of Rs. 5,000 was given by the Agricultural Adviser to the Government of India for experiments with small power cane mills, capable of being driven by the small oil-engine used for pumping.

Two mills are at work at the Shahjahanpur Research Station :—

(1) A fairly large mill crushing 15 tons per day of 10 hours requiring approximately 20 H.-P. and costing in times of peace Rs. 2,250.

(2) A small, *i.e.*, a mill crushing 12-15 maunds per hour requiring 5-7 H.-P. and costing Rs. 450.

The efficiency of the smaller mill has been thoroughly investigated. It gives an expression of 55-59 % with Utah canes and 62-66 % with Pounda canes.

The efficiency is better than the village mill as ordinarily used but not so good as the heavy bullock mill used at the farm. The latter, however, is entirely beyond the bullock power of the cultivator and the rate of crushing *is 2 maunds* per hour.

It is proposed to issue a certain number of the smaller type of mill and it is anticipated that they will meet a very pressing need in the United Provinces.

(4)

PUNJAB.

[J. H. BARNES, B.Sc., F.I.C.]

Experimental Investigations, 1914-15. The testing of varieties has been continued at Gurdaspur and a first selection made. Eliminating those canes which are obviously too delicate for this part of India, 33 varieties in all *have been under test (see Annual Reports)*.

A permanent series of manurial experiments have been started in 1915.

The survey of the canes of the Gurdaspur District has been completed and the average yields per acre and general chemical composition of the juice determined. During 1914-15, the survey has been extended to the Karnal District in the Southern Punjab where it is found the canes yield over some 30 % higher in Gurdaspur.

I am of the opinion that it will be an unsound policy to attempt to force cane cultivation north of Karnal for climatic reasons and because cotton will ultimately prove a more profitable crop.

We shall continue to examine the canes of the Southern Punjab with the object of improving cane cultivation there and possibly introducing improved *gur* making machinery, if such machinery proves successful elsewhere. Under present conditions there is no likelihood of successfully introducing and using more elaborate machinery for refining purposes. This part of the Punjab seems to be the northern limit of canes of fair quality and the standard of cane is maintained by the introduction of seed cane from the United Provinces.

Sugar beet has been under trial at Lyallpur for the past four years and can be grown there yielding a fair crop (about 50 maunds of sugar to the acre). The difficulty in handling this crop on a large scale for sugar making is that the sugar contents will fall unless the seed 'beet' be produced in a cold climate near at hand. The Director of Agriculture, Kashmir, is growing beet from North German seed for us, and we are testing the beets grown from this Kashmir seed at Layalipur. So far, the results appear satisfactory. The only possibility of a central refinery in Northern India seems to be in a factory designed to deal with the dual crops, cane and beet, by means of a diffusive plant.

In addition to the above field work, laboratory investigations have been made in connection with the following subjects :—

(a) *The effect of frost on the composition of cane juice.*

(b) The conservation of sugars in the pith cell of the cane.

(c) The enzymes of the cane leaf.

The results of these investigations will be shortly offered for publication.

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(5)

BOMBAY.

(a)

Increase in Canal Irrigation in the Bombay Deccan denoting a certain increase in Cane-growing in the near future.

[G. F. KEATINGE, C.I.E., I.C.S.]

During the past few years the Godaveri canals, Right and Left banks, have been open for perennial irrigation, the Pravara canals, Right and Left banks, are just about to open for perennial irrigation. The Nira Right bank Canal is under construction and the work is far advanced. The Gokak Canal project has been sanctioned. These canals run through much country suitable for cane-growing, and the people are keen to grow cane.

Under these canals there will probably be about 800,000 acres of irrigated crops of which about 80,000 will probably be sugarcane. This means a great addition to the area under sugarcane in the Bombay Presidency, and the cane-growing will be fairly concentrated.

The above figures are rough estimates, as I have no papers with me to refer to.

(b)

Note on the Progress in Sugarcane Cultivation and in the Manufacture of Gur.

[RAO BAHADUR G. K. KELKER.]

Economy in the cost of cultivation on the Manjri farm. The cost of preparatory tillage has been reduced to nearly half of what is incurred by the cultivators in the Mutha valley, by the use of Gallows plough, Disc harrow, leveller, cultivator and ridger.

It has been already found that a fairly large percentage of hand labour in the sugarcane cultivation can be substituted by quick and cheap bullock labour, if cane is planted in straight long furrows 5 feet apart as the gradient of the land would allow. This facilitates the use of interculturing implements for removal of weeds and earthing up of sugarcane by the use of the 'Saboul plough'.

Another item of heavy expenditure in growing sugarcane is the cost of sets. According to the present practice the sets are planted indiscriminately at the rate of 18,000 per acre. But if they are planted carefully so as to have all the buds on the sides, a better germination and an even stand are secured. By taking this care in planting it has been found to be possible to reduce the number of sets by half (9,000 sets) without decreasing the outturn.

Miscellaneous savings. The scum strainer which costs about Rs. 5 can save juice worth Rs. 20 per acre. Usually this is wasted along with scum.

New method of planting. The local system is to plant sugarcane in beds, the distance between two rows being 2½ feet. Experiments have shown, however, that if cane is planted 5 feet apart in continuous rows the yield is as good or even more than that in the local system. The advantages in the new system are that (a) the manual labour *can be considerably substituted by bullock labour as the interculturing and weeding can be done by the single* bullock-hoe. By this method not only the weeds are kept under control, but it leaves a good mulch on the surface which helps in the conservation of moisture. In the local method earthing up is required to be done by hand, but the same work can be profitably and quickly done in the new system by means of a plough within one-fourth the usual cost.

Manures. Experiments have próved that the most economical top dressing for sugarcane is a combination of safflower cake and ammonium sulphate each to supply 75 lb. of nitrogen per acre in addition to the usual quantity of *farmyard manure (30 cart-loads = 10,000 lb. dry matter).*

The sugarcane growers in the Mutha Valley apply generally 60 cart-loads of farmyard manure before planting, about 5,000 lbs. of castorcake as top dressing. The total cost of this per acre comes to Rs. 267. But when the manure is applied as recommended by the farm, the total cost per acre comes to Rs. 147 only ; this means that nearly double the area can be manured adequately in the same amount.

Trash has been found to be a good substitute for farmyard manure. 12,000 lbs. trash is obtained from one acre of sugarcane and this is quite sufficient for manuring one acre of new cane, provided none of it is used for fuel. By the use of the improved furnace at least about half the quantity of trash can be saved, valued at Rs. 30 per acre.

Green manuring the land with *san* in the previous year of planting sugarcane has given excellent results. The results show that *san* can be entirely depended upon for furnishing the course manure required for sugarcane.

Ripeness of cane. The use of the Brix sacoharometer for determining the ripeness in cane is becoming popular amongst the cane-growers. In the case of Pundia sugarcane which is the common local variety, the cane is said to be ripe for crushing when the reading is 20° by the Brix saccharometer. It has been observed on several occasions that the cultivators usually crush their cane when the reading is about 18 Brix.

Mills. Trial of different mills was continued. Amongst the bullock-driven mills, Chatanooga mill No. 23 seems to be a better substitute for the Poona iron mill in point of extraction, durability and finish, but it is a little bit costly. The mill is found to extract 2 per cent. more juice than the Poona mill.

Hatti mill also gives good extraction and seems to be a suitable one for introduction in tracts where thin canes are grown.

The power crushers so far introduced in the sugarcane tracts of Bombay are only suitable for large estates. For smaller sugarcane farms of 10 to 20 acres another power crusher Chatanooga No. 44 was tried. The work of this crusher was found to be satisfactory, and it is found that 4 per cent. more juice is extracted by this mill over that

of the local mill and it is quite suited for cultivators growing 10 to 20 acres of sugarcane. The chief advantage with this mill is that the work of crushing could be finished in one-third the period ordinarily required by the local mill and thus avoid the keeping of the cane as Adsali (18 months crop).

The Poona mill with screw arrangement is an improvement over the local mill in tightening the mill by replacing the ordinary wedges with screws. It is experienced that the present tightening arrangement is unsatisfactory, because the gangmen loosen very often the rollers by drawing out the wedges to reduce the draught and hurry up the work of crushing. Another improvement made in this mill consists in the addition of a wedge for the central roller to keep it in position. These improvements have been brought about by Mr. Dhavle of the Satara district.

The statement of trials is given below :—

Name of mill	Price	Length and diameter of rolls		No. of persons engaged near mill		Extraction from 100 lbs. of cane	Make and Finish	No. of bullocks or B.H.P. required	Cane crushed in one hour	Name of Firm or Agents
		Main	Side	Men	Women					
	Rs. A. P.								lb.	
Power crusher .	2,235 0 0	14" × 20"	14" × 20"	2	7	72	Fine and strong engine.	14 B.H.P. engine.	4,500	Messrs. Greaves Cotton & Co., Bombay.
Chatanooga power crusher No. 44.	950 0 0	9" × 9"	6" × 9"	1	2	70	Do.	5 Do.	1,600	Messrs. Marshall Sons & Co., Bombay.
Chatanooga No. 23	200 0 0	14" × 7"	7" × 7"	3	..	68	Do.	4 bullocks	750	Do.
Poona mill with screw arrangement.	175 0 0	11" × 18"	11" × 16"	4	..	66	Rough and strong	4 Do.	750	Messrs. Bari of Poona.
Poona ordinary mill.	150 0 0	11" × 18"	11" × 18"	4	..	64	Do.	4 Do.	750	Do.
Hati . .	90 0 0	9" × 9"	Feed roll 7" × 7" megass 9" × 8" roll.	2	..	68	Fine and strong	2 Do.	375	Messrs. Burn & Co., Calcutta.

Furnaces. The Poona furnace has been adopted by many cane-growers in most of the districts of the Deccan. The double furnace is also being taken up in many places in Satara, Sholapur and Nasik. The multiple furnace, which requires large quantities of sugarcane juice at a time, is only suitable when power crushers are used.

In addition to the saving of time for boiling per pan, the improved furnaces save about half the quantity of trash (Pachat) which can be profitably used as a substitute for farmyard manure in localities where it is not obtainable in sufficient quantities.

Season of planting with respect to the attack of the borer. The moths of the stem borer lay eggs generally in the month of March. Cane-growers who plant their cane late, get their crop attacked by the borer to a great extent. It is now determined by our experiments that if cane has a vigorous stand and is of about three months old by this time, it resists the attack of the borer. It is, therefore, recommended that the cane should be planted in the months of December and January to resist the attack of the borer.

Cane varieties. Several Indian and foreign sugarcane varieties brought from the Samalkota Farm during the year 1909, B 208, B 376 and J 36 are equally rich with the local Pundia variety and these have been grown on field scale now.

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(6)

MADRAS.

Note on the work of the Cane-breeding Station at Coimbatore.

(C. A. Barber, M.A., Sc.D., F.L.S.)

As the question of the continuation of this Station will come before the Board, the following resumé has been prepared of the work done. It has been cast in a somewhat unusual form whereby, however, the results can be most conveniently presented, and the future work indicated.

The main object of the Cane-breeding Station is to supplant inferior local canes all over India by others, yielding more *gur* or sugar and capable of being grown under similar conditions of soil and climate. It was decided that this problem should be approached, in the first instance, by an attempt to raise seedlings. The following problems have presented themselves during the three years since the work was commenced :—

(1) To select a suitable site.

(2) To obtain sugarcane seedlings in India.

(3) To collect as many varieties in the Station as possible, to acclimatise them to the farm conditions and, ultimately, to make them flower.

(4) To obtain seedlings with a high percentage of sucrose in the juice, great vigour and good habit characters.

(5) To obtain seedlings suited to the varying conditions of soil and climate in India.

(6) To test the permanence of their characters when seedlings are reproduced by cuttings ; and, ultimately, when they are grown under field conditions in the locality for which they are intended.

(1) *Selection of Site.*

Flowering of canes is comparatively rare in India, but it does occur in a number of places, sometimes at rare intervals, sometimes habitually. Coimbatore was selected as the site of the cane-breeding station because it had been noted that in every year the cane fields were covered by a mass of inflorescences. Besides this, the presence of a well-equipped laboratory would save delay in putting up the necessary buildings.

The land chosen was dry, well-irrigated or garden land, in that the usual cane wet land was not thought suitable for seedlings intended for North India.

(2) *To obtain sugarcane seedlings.*

These were obtained after a study of the cane flowers. There is no means whereby female fertility can be predetermined in these flowers, but the presence of open anthers generally means plenty of fertile pollen. The anthesis of cane inflorescences has been carefully recorded from the start. The following is an example of the percentage of open anthers in different parts of India :—

Saretha flowers in 1915-16.

Anthers all closed at Sipaya (Bihar), Shahjahanpur, Jubbulpore, Sabour; 4 per cent. open at Pusa; over 90 per cent. open at Coimbatore.

(3) *Collection of varieties and their acclimatization. Making these varieties flower on the Station.*

The collection of varieties of Indian canes on the station is far from complete, and will naturally largely depend on the work of the local Agricultural Departments. Thus far 112 varieties of indigenous Indian canes have been collected and 120 thick introduced canes, these figures naturally including some duplicates under different names.

At first these canes grew very poorly on the station at Coimbatore as the land was not in a fit state for sugarcane growing; but this difficulty has been overcome, and the slightly saline nature of the farm largely corrected. The following is the routine method which has been found most successful :—A dressing of tank silt followed by deep ploughing and a crop of irrigated Juar; *Dolichos Lablab* or field bean grown as a green dressing and ploughed in; thorough draining of the land and the planting of the cane sets in trenches with prepared soil. Almost all of the station has now been thus treated and the growth of the North Indian canes is excellent.

Making the canes flower was more difficult, but a study of the local fields showed that it depended largely on the time of planting. Planting on garden land is usually done in February-April and on wet land a good deal later. There is another planting season, namely, August to November, and it was found that all the arrowing local fields have been planted at this time. "Arrowing plots" were accordingly opened on the farm, planted in November. The result has been eminently successful, as is shown by the following figures :—

1912-13 Botanic Garden : 3 thick and 3 thin canes flowered.

1913-14 Cane-breeding station : none flowered (planted in May).

1914-15 Cane-breeding station : planted in November, 5 thick canes and 4 thin flowered.

1915-16 Cane-breeding station : planted in November, 35 thick canes and 36 thin or North Indian canes flowered.

Incidentally, it has been noted that the season has great influence on the flowering of the cane, and the past season has been quite exceptionally favourable. The following canes have been reported as flowering this season (October-December) :—

Dacca 1, Shahjahanpur 2, Pusa 3, Sipaya 6, Jubbulpore 6, Telinkheri, Central Provinces 16, Coimbatore 71.

(4) *To obtain seedlings with a high percentage of sucrose in the juice, etc.*

The seedlings of the first two years were of poor quality in this respect, but with the large accumulation of varieties on the station great advances have been made. The following table gives the percentage of sucrose in the juice in the selected seedlings of each year :—

—	Total quantity	Over 17 per cent.	Over 18 per cent.	Over 19 per cent.	Over 20 per cent.	Over 21 per cent.	Over 22 per cent.	Over 23 per cent.	Selected
1911 seedlings analysed in 1913 .	48		0	0	0	0	0	0	All grown on.
1912-14 seedlings . . .	2,068	95	40	9	2	0	0	0	148 over 17 per cent.
1913-15	2,400	250	128	101	22	3	1	1	256 over 18 per cent.

Vigour and good habit characters. Each year there has been a more rigorous standard set for selection of seedlings with good sucrose content to be grown on. Vigour has been used to eliminate an increasing number. But habit character has not as yet been sufficiently attended to, in that it has been impossible to judge of this, because of the high winds during the ripening of the seedlings (April-August). To judge the habit characters we have to wait till the third year when the seedlings are reproduced vegetatively from cuttings.

(5) *To obtain seedlings suited to different parts of India.*

This problem must be considered as of vital importance. India, with its enormous extent and variations in temperature and rainfall, cannot be compared with any tropical country where cane seedlings have hitherto been raised. The bulk of the seedlings thus far obtained are the progeny of thick canes, many of which are entirely unsuited to growth in North India, although perfectly at home in Madras and Bombay and to a less degree in the Central Provinces, Bengal and Assam. It is true that among these seedlings some may be found more suited to the climate of North India, but, taken as a whole, they may be regarded as more or less undesirables.

The ideal set before us from the start has accordingly been to obtain crosses between thin (local indigenous) canes and thick (introduced tropical) ones. The method proposed is to select the best local cane of any one locality, grow it and make it flower, cross it with good thick canes and, from the seedlings obtained, select the best for trial in that locality. Thus we see that the work of the cane-breeding station resolves itself into a series of difficult pieces of research, one for each of the great sugar tracts of India.

The bulk of the North Indian canes do not flower in their own country. We have succeeded in causing 28 varieties of them to flower at the cane-breeding station but most of them have proved more or less infertile to commence

with. We have to determine whether this is a purely varietal character or the result of insufficiently perfect acclimatisation. Our present experience appears to point to the former. All members of the great Chin group, Katha, Chin, Saretha, Lalri, Kansar, occupying by far the greater area under indigenous canes in the Western United Provinces and the Punjab, have flowered freely and produced masses of seedlings, and a very large programme of crossing has been carried out between them and thick canes. Almost all of the Pansahi group (Eastern United Provinces and Bihar) have flowered, but have shown great infertility, while the few members of the Mungo group (covering the same area) which have been induced to flower, have inflorescences which have hardly emerged from their enveloping sheaths. These latter canes have probably not flowered for thousands of years, and it remains to be seen whether the change to warmer conditions will have the desired influence and seedlings can be obtained.

The following is the list of canes obtained during the current season at the cane-breeding station :—

Parents—

Thick canes recently introduced into India	950
Thick canes acclimatised in Coimbatore	9,065
Thick canes acclimatised in North India	500
Thin canes indigenous in India	5,882
Coimbatore seedlings (largely for special studies)	9,760
Vellai crosses ? (local thick Coimbatore cane)	122
Thick canes mothers, thin fathers ?	1,214
Thin canes mothers, thick fathers ?	312
Pansahi mother, Saretha father ?	30
Small lots of varying nature	22
TOTAL	28,757

From these selections will have to be made of about 4,000 for growing on and testing in due course.

(6) *To test the permanence of their characters, etc.*

A seedling takes 18 months to mature so that its juice can be analysed. Owing to the restricted time of flowering (October-December), it ripens during May-June, a time entirely unsuited for its proper development in the Coimbatore climate. To bring it into line, the cuttings must be sown in the following February and reaped a year later. It is considered necessary for determining the fixity of its characters to grow it for two further years before it can be safely distributed. All this then takes time.

To give an example, the 4,000 seedlings, referred to in the last paragraph, will be first analysed in May-June, 1917, they will then be rigorously selected and the selected seedlings (say 200) will be planted from sets in February 1918. They will be grown on for two further years and thus be ready for distribution to the local farms in February, 1921.

After this comes the period during which they are tested in the localities for which they are intended, before they can be distributed to the cultivators, but this part of the work does not fall within the scope of the cane-breeding station.

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(7)

CENTRAL PROVINCES AND BERAR.

(C. G. LEFTWICH, I.C.S.)

The numbers of paras are those given in the Committee's report printed on pages 15 to 18 of the Proceedings of the Board for 1911.

(1), (2) and (3). We have no special work on chewing canes except to meet purely local demands and to that end aim at procuring a variety of soft cane, free from attacks by disease, but without regard to sugar contents. Our activities are directed mainly to obtaining higher productivity, and also to improvement in the manufacture of *gur*, with some success (*e.g.*, the *gur* made on the Government Farm at Adhartal, Jubbulpur, fetches the highest price of all in the local markets). The use of the thermometer has been successfully tried.

(4) We have tried various bullock-driven mills and are pretty well satisfied with the "Nahan" (both two or three roller) which give an outturn of about 70 per cent. of juice, more or less according to the thickness, etc., of the cane : the steam driven power mill used at Sindewahi gives an outturn of about 60 per cent.

As regards boiling, much progress has been made in the introduction of under draught furnaces, locally known as the Poona pattern. This can probably be still further improved, for instance, in the form and size of the chimney. This innovation is of very great importance. Probably one of the principal factors in causing the decline of cane cultivation in the districts of Betul and Chhindwara has been the growing expense of fuel : this can now be dispensed with and cane refuse used instead. This is being demonstrated this year at 10 centres in these two districts. In the Southern Circle nearly 100 Poona furnaces have been set up for cultivators already.

(5) (*a*) Work on cane is now being carried on at agricultural stations in the Central Provinces including the newly instituted farm at Betul.

(*b*), (*c*) Much has been done in both the Northern and Southern Circles and testing is going on. In both Circles, a good start has been made in the distribution of the best imported varieties. Some ',000 Mauritius canes were *sold by the Department last month in Betul.*

(*d*) In the Southern Circle, Mr. Clouston has got nearly 300 "Nahan" mills sold in the last 4 years and as many as 50 in Chanda in the last two months. In the Northern Circle Mr. Evans has sold over 300 "Nahan" mills in four years, and in Jubbulpur the country "Kolhu" or wooden mill, is no longer to be found at all. The sale of the "Nahan" has been largely helped on by the Co-operative Central Banks.

(6) Our Economic Botanist (Mr. Graham) has just started work upon the *local* varieties from both circles. Hitherto we have relied entirely upon Dr. Barber and the study of local canes is new.

(7) No remarks.

(8), (9), (10) and (11). At present there is no sugar refinery in the Provinces. The concession of land on special terms to Mr. McGlashan's Syndicate has resulted in the clearing and cultivation with cane of some 100 to 120 acres. So far uncertainty as to the behaviour of the irrigation tank commanding the area, and of its feeder channels has militated against rapid development. It is probable that the sugar refinery proposition will be shelved and a *gur* factory put up in the first instance. So far, no active assistance in the form of a subsidy has been given.

(12) and (13). *There are large areas of land, some cultivated and some waste, under the irrigation works now* nearing completion, of which a considerable proportion would be suitable for cane cultivation. We are already

experimenting in such areas, as for instance, at Raipur, Chandkhuri, Tharsa and Sindewahi in the Southern Circle. But we have to go slow before pressing on any great extension of cane cultivation until we see how these works will behave. We wish to avoid any set-back in any particular area owing to the failure of a work to act up to what is expected of it in the matter of water supply to the fields. But in these tracts are mostly to be found some secure smaller works, so it is safe to go on testing at our farms and demonstrating with a view to steady extension. Rapid extension is in any case not to be looked for owing to the natnre of the population.

(14), (15) and (16). No further action is contemplated in the Central Provinces until we see what comes of Mr. McGlashan's ventnre in Chanda.

General.

Most of the details which I have not mentioned above will be found in—

(*i*) the programmes of work in the Northern and Southern Circles for 1916-17 ;

(*ii*) the annual reports on the Agricultural Stations in those Circles for 1914-15 ; and

(*iii*) a paper in the *Agricultural Journal of India*, Vol. X, Part 3, for Jnly 1915, on "The *Gur* Industry in the Central Provinces" by Messrs. Clonston and McGlashao. Under head (5), I add the following details :—

We have 32 acres of cane at Sindewahi Farm :—

13	Tharsa.
10	Raipur.
5	Jubbulpur (Adhartal).
3	Hoshangabad (Powarkhera).
1½ *	Betul.

* First year.

There are above 50 varieties under observation. Of these, Java 247, Khari and Sannabille are the most promising of the thinner and harder varieties ; Ashy Mauritius and Pounda in the Southern and M. 16 and Bethar in the Northern, of the thick canes.

Smut is said by Mr. Evans to be a serious problem in the Northern Circle, Red-rot and Borer in the Southern. Mr. Clouston has had to condemn some varieties owing to their apparently excessive susceptibilities ; the worst are perhaps striped Mauritius and Red Sport : Java 36 and 247 have also got disease this year, the former in both circles. They have escaped on the Tharsa Farm. Selection by shoots to eradicate Red-rot has been started in both circles, on the Madras method.

The best ratooning cane is Khari. The combination of Java trenching and green manuring with Sann hemp was quite successful in the Southern Circle.

Green manuring with Sann hemp followed by top-dressing with 15 to 20 maunds of *til* or castor-cake promises to be the most economical.

With one Nahan mill the cultivator can crush ¾ ton of cane per diem. Sixteen days to crush 12 tons. This means monopoly of bullocks for 48 days to extract juice from the cane of 3 acres. The 9 B. H. P. engine used at Sindewahi (steam power) crushes one ton per hour. Its percentage of juice extracted is somewhat less, but the general economy is great and we propose to try and get a plant started co-operatively.

Using the thermometer to fix the optimum temperature at which to stop boiling has resulted in the production of greatly improved *gurs* at Tharsa and Jubbulpur.

(8)

ASSAM.

(A. A. Meggitt, B. Sc.)

(1) *Extension areas.*

The scheme approved by Government was to reclaim waste grass land in Kamrup, to put it under cane, commencing on a small scale increasing this during the period of 3 years to 1,000 acres. Capitalists were then to be invited to inspect the site, and large tracts of land of a similar nature were to be offered to them for factory work.

Work was commenced early in 1914 on an area chosen by Mr. Birt, Deputy Director of Agriculture, Assam. Some 40 acres of land were with great difficulty reclaimed by bullock power in January, February and March, 1914. Twenty-five acres of this was planted out with canes sent from Jorhat being striped Mauritius, B 376 and B 147. This was intended to supply "seed" for the following year's work on a larger scale on the arrival of the steam tackle. A larger area could not be planted as our supply of cane ran out. The cane was planted in March and April 1914 ; it got away well at the start, but subsequent flooding from areas lying to the North checked it, and the crop was not a big one.

The experience gained showed that the site was low, and liable to excessive flooding. Accordingly a new site was chosen in August 1914 lying some 2 miles due north of the first, and which appeared less liable to flooding.

Two blocks of 60 acres each, *i.e.*, 120 acres in all, were ploughed up and prepared for planting in January-March, 1915. This work was done by the steam tackle which only arrived in December, 1914.

Some 70 acres were planted out in April, 1915, from cane derived from the old site. Planting was admittedly late, but this was unavoidable on account of the late receipt of the steam tackle, and the distance of the old site from the new. The year 1915 proved to be one of disastrous floods. The first floods occurred during May, before it had been possible to complete our drainage scheme, and before many of the canes had germinated. Some 87 inches of rain fell between the 1st May and 15th August.

In consequence, on the lower lying parts of the area, some of the cane was drowned in large patches.

After the cessation of the heavy rains, the cane made wonderful growth, and on the higher lying areas, though somewhat immature, it has made a good crop. Tillering is extraordinarily good, and the crop is extremely healthy. On the whole, in the light of experience gained last year, there appears to be every prospect of success this year. The rainfall in 1915 was 113 inches which is considerably above the normal.

Four new blocks of 60 acres each, *i.e.*, 240 acres, have already been reclaimed for the current year's work and planting will commence at once. With earlier planting and a thorough scheme of drainage which has been drawn up in consultation with Messrs. Milligan and Barber, there is every prospect of success in 1916, especially if the year is one of normal rainfall.

Even should the rainfall again prove excessive, there is every reason to hope that, with the tackle now at our command, and the drainage work now being carried out, we shall be able to weather—and more than weather—the storm. We hope to have 300 acres under cane this year.

Under the original scheme this experiment is to terminate in March, 1917. By that time it is by no means certain that we can settle the problem of economic cane cultivation in this tract. The difficulties encountered and which could not possibly be foreseen, have been very great indeed, and we are only now in a position to tackle the scheme properly.

An extension of time is desirable if we are to acquire the necessary information.

Before the cost of production can be definitely ascertained we have to determine two things :—first, the capacity of the Steam Tackle unit, and second the capacity of the soil. This will obviously take time.

If an extension of time be granted, it is proposed to confine our efforts to a more modest scheme than that originally elaborated, a scheme under which we shall work up to such an area as can be kept in thorough cultivation by the Steam Tackle unit we have, and which further will embrace a rotation of cropping having in mind the necessity of maintaining the fertility of the soil at as high a pitch as possible.

(2) *Work already in progress to assist cane-growing.*

(a) "Survey and testing of local varieties under chemical control." This has been continued, and certain local varieties previously thrown out have been given further trial in view of improved soil conditions at Jorhat. They prove themselves, as before, incapable of competing with our exotic varieties under conditions obtaining there.

(b) "Testing of such imported varieties as appear *prima facie* suitable."

This work has been continued with the Barbados and Mauritius canes imported some years ago. In addition, three new varieties, received direct from the West Indies, are being grown and will be given field plots this year.

Six new varieties sent by Dr. Barber are also being grown, and will be put out on to field plots next year.

(c) "The distribution of the best varieties so determined."

This has been actively pushed, and demonstrations have been made on cultivators' holdings along side local cane.

Some 75,000 sets were distributed of the three best varieties, *viz.*, Striped Mauritius, B. 147 and B. 376, last year in the Assam Valley.

(d) "The demonstration of improved mechanical methods."

Demonstrations of the three-roller iron bullock mill were made in both valleys, and were very successful, and the demand for these mills is increasing.

Iron mills were also let out on hire to cultivators.

(e) "The study of the question of tillage, watering, manuring, and draining in the light of local conditions, so as to increase the average outturn per acre."

Experiments on these aspects of cane cultivation (except watering) have continued at Jorhat.

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(9)

BURMA.

(A. McKerral, M.A., B.Sc.)

1. In 1913, a Rangoon firm approached Government with the suggestion that they should conduct an experiment in sugarcane growing in the Môn Canal tract of the Minbu District and Government agreed to pay half the cost of the experiment, *viz.*, Rs. 10,000, on condition that if the experiment was a success the Company should erect a white sugar mill in the locality and work an area of about 10,000 acres. To conduct the experiment an expert was to be brought from Java to make observations and record results during the space of at least one year. With the outbreak of the war in 1914, these arrangements were suspended.

2. In 1913, a small area of about 10 acres was chosen for a seed distribution farm at Pwinbyu in the Môn Canal tract and stocked with seed of the principal Burma variety, the Pyinmana red cane. During the cultivating season of 1914, seed canes sufficient to stock about 40 acres were distributed from this farm among the members of Co-operative Credit Societies and the crops from this seed are now being cut. It is expected that most of the canes from this area of 40 acres will be used this year for seed, so that a rapid increase in the area under cane in this Canal tract may be expected in the near future. Owing to the enhanced prices of jaggery since the outbreak of war, there has been an increasing desire on the part of cultivators to grow sugarcane and make jaggery.

The work of extension of sugarcane cultivation is at present solely confined to the Southern Circle. In this Circle district work is in the process of organisation and district agriculturists have been appointed in six districts, while four more are under training and will go out during the present year. The extension of the growth of sugarcane forms part of the programme of each of these men and in the Thayetmyo and Toungoo districts distribution on a small scale with a view to forming centres of seed distribution has taken place.

3. An experiment is in progress at the Hmawbi Agricultural Station to test the possibility of rotating sugarcane with paddy on the main paddy areas of Lower Burma.

4. A good deal of attention has been given to the questions of power crushers and improved furnaces to be worked by Co-operative Credit Societies and proposals were submitted to a departmental conference by the Deputy Director of Agriculture, Southern Circle, for a plant costing about Rs. 10,000 to work 50 acres of cane in the Môn Canal tract. The Registrar of Co-operative Credit Societies, however, considered that the financial condition of the Societies in the tract was not good enough to warrant this expenditure in the near future, and it was accordingly decided to confine work in this area at present to demonstration of the proper methods of growing the cane and of jaggery boiling. In connection with the latter trained jaggery boilers were brought from Pyinmana and conducted demonstrations at the Pwinbyu farm in February and March 1915.

It is proposed at present to supply Societies with the smaller types of bullock power crushers and several of these have already been sold.

As this tract, the irrigated area of which is over 100,000 acres, is highly organised co-operatively it may be confidently predicted that sugarcane will soon become established on a fairly extensive scale, and that when the area is sufficiently large the erection of a white sugar mill will become a possibility. So far as is known at present this is the only new area in the Province where sugarcane can be grown on a scale sufficient for this purpose.

The first crop grown at the Pwinbyu farm yielded about 30 tons per acre without manure, and there is obviously a very large proportion of the irrigated area where similar crops could be grown.

NORTH-WEST FRONTIER PROVINCE.

(W. Robertson-Brown.)

The total area under sugarcane in the North-West Frontier Province is 32,000 acres of which 25,000 acres are in the Peshawar District where thick canes are grown. The crop is raised under irrigation from the Kabul River Canal and the Upper and Lower Swat Canals.

Mechanical aspect.—Gur. The 3-roller "Sultani" mill is used throughout the Province.

The mills are mostly the property of the village headmen, and each is hired to a group of 3 or 4 cultivators whose area of cane may be 5 to 7 acres.

Crushing and boiling are carried out in the cane fields: not in the villages. The cane is conveyed to the mills by villagers and trans-border women who accept the cane tops in payment of their labour.

The growers combine in sending their bullocks to work the mills and their boys assist in making the *gur*. The extraction of juice varies considerably, but may be about 70 per cent. juice to cane. The method of boiling is simple and no fuel is purchased. The begasse and dry leaves boil the juice. (It may be noted that the entire foliage of the canes is dry and dead when crushing is in progress.)

The Peshawar method of boiling appears to be quite as economical as the Poona method, and after trial of the latter the people have decided in favour of their own method. As Peshawar *gur* is mostly exported to the Punjab and realises the highest market prices there, the practices in vogue in the North-West Frontier Province appear to be satisfactory, and they are on the whole economical.

White Sugar. Estimates for a miniature experimental factory to deal with 2 tons of sugar per day have been received and are now being considered by the Administration of the North-West Frontier Province. It is desired to ascertain:—

(*a*) the value of Peshawar sugarcane,

(*b*) the possibility of storing cane during February and March for manufacture,

(*c*) whether the cultivators would grow beet and at what price,

(*d*) the value of the sugar beets for manufacturing purposes. The total cost of the sugar factory for sugarcane and sugar beet is estimated by the Harvey Engineering Co. to be Rs. 1,50,000. (One and a-half lakhs).

Agricultural aspect. Surveying and testing varieties.—There is practically only one variety of cane in the North-West Frontier Province and this has proved inferior to several imported varieties in yield and in quality. Local and imported varieties were tested at Peshawar by the Imperial Agricultural Chemist throughout the cane-crushing season, 1914-15. On reasonably cultivated land, the average weight of cane per acre is not less than 25 tons. The following figures were ascertained at the Peshawar Agricultural Station on an acre (the acre was one of a 6 acre block of cane) of cane in December 1915.

Province and cane	PER ACRE. Number of canes	Weight of canes	Weight of juice	Weight of *gur*	Juice per cent cane	Gur per cent. cane	Gur per cent. juice	Cost of producing 5460 lb. *gur*	Value * of 5460 lb. *gur*	Net profit per acre	Return on outlay per cent.
								Rs. a. p.	*Rs. a. p.*	*Rs.*	
North-West Frontier Province.											
White Peshawari .	40,800	62,192	44,832	5,460	72·08	8·77	12·17	301 4 0	480 10 7	179	59·5
Poona.											
Poona Pundia .	..	97,152	64,104	11,950	66·04	12·3	18·62	458 2 5	756 7 0	298	53·4
Cawnpore.											
Ashy Mauritius .	..	54,439	..	3,168	63·7	7·5	11·5	....	..	..	..

Rate of *gur*, 1915, Rs. 7-6-3.
Rate of *gur*, 1910-15 Rs. 6-8-0 (about).
* @ Rs. 7-8-0 per maund of 82 lb.

Relative profits on the basis of figures given above, of gur-making and selling cane direct to a factory.

	Cost of cultivation, boiling, etc.	Value of *Gur*	Profit
	Rs.	Rs.	Rs.
Gur	301	480	179
		Value of 758 mds. of cane @ 0-5-0 per maund	Profit.
	Rs.	Rs.	Rs.
Cane sold to a factory . .	166	236	70

Evidently it pays to produce *gur*. The cost of cultivation would of course be much reduced if a factory owned or leased and cultivated an extensive area of cane.

One and-a-half acres of canes were pitted in 1914-15 to find if cane could be stored from December to 1st April without loss of cane or sugar.

The Imperial Agricultural Chemist found that very little loss occurred, and it may be assumed that the cane rushing season in Peshawar extends from 15th November to 15th March when sugar beets are at their best

Sugar Beets. Beets have so far been grown at the Peshawar Agricultural Station only: it was not possible to procure good seed for extensive trials on cultivators' lands. The Imperial Agricultural Chemist conducted a series of analyses and tests at Peshawar throughout the season, 1st March to 15th June 1914, and found—

(*a*) the percentage of sucrose in the juice to be 15·56;

(*b*) the weight of roots to be 18 tons per acre, and

(*c*) successive sowings made in September, October, November and February ripened in the period March to June. The cost of cultivation is about Rs. 70 per acre.

Beet seed sown on 10th February, on sugarcane land, after cane was cut in January, ripened over 18 tons of roots per acre on half an acre of land.

The crop is as easily grown as turnips.

Area for extension. A large area of thinly populated land has recently been brought under irrigation in the Peshawar district, and the present area of sugarcane might readily be extended from 25,000 acres to 50,000 acres, chiefly on the new Upper Swat Canal.

It may be noted that Peshawar Valley and the newly irrigated area is traversed by a railway. There would not be any difficulty in sending cane by light rails on the canal banks to any situation suitable to a central factory An area of 5,000 acres (the property of one owner) or more, could be leased by the factory.

The chief factor in preventing the extension of sugarcane cultivation in the North-West Frontier Province is scarcity of manure. But the Province has green manure crops of some value, and if a factory set to work chemical manure could perhaps be economically employed.

Even though Louisiana produces 400,000 tons of white sugar annually under climatic conditions less favourable to loss than those prevailing in the North-West Frontier Province, the writer thinks it probable that white sugar would be more profitably produced from sugar beet than from canes in this Province.

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(11)

MYSORE.

(Dr. L. C. Coleman, Ph.D.).

Increase in Area. The area under sugarcane in Mysore varies roughly between 40,000 and 50,000 acres. The fluctuations are due for the most part to variations in the supply of water in the tanks, the chief source of irrigation water for sugarcane in Mysore. The possibilities of expansion are very considerable. On the 20,000 or 25,000 acres under the large Marikanave Reservoir, practically no sugarcane is grown, the chief reason being that the ryots in that section of the country have had no experience in its cultivation. The Mysore Government have recently sanctioned the opening of a farm in this tract among whose chief functions will be the demonstration of methods of sugarcane cultivation and jaggery making and the supplying of good sugarcane seed for the tract. It is hoped by this means to increase the area under sugarcane from 5,000 to 8,000 acres.

The construction of the Kannambadi Dam across the Cauvery will open up a considerable area for sugarcane cultivation, and it is probable that a sugarcane farm will be established in this area also. Lastly, the possibility of utilising water from the many rivers and perennial streams, more especially in the western part of the State, is receiving the attention of the Industries and Commerce Department and a considerable number of pumping plants have been erected for this purpose. Altogether there seems little doubt that the area under sugarcane will be doubled within the next ten years.

Improvement in cultivation. The use of iron ploughs for the cultivation of sugarcane land has spread very considerably within the past two or three years. Out of approximately 1,000 ploughs which the Agricultural Department is now selling per annum we are safe in estimating from 75 to 100 as having been bought chiefly for this purpose.

In large areas in the State the use of manures other than the cattle manure for sugarcane is unknown. To popularise the use of oilcakes in such areas, arrangements were made by the Agricultural Department last year to distribute small quantities on the understanding that the cost would be collected after the harvest of the crop when the results would be evident Over 200 tons of oil cake were distributed in this way and the results have been very satisfactory. This distribution will be very greatly extended during the present planting season and next year the question of the feasibility of establishing co-operative manure supply depôts in important sugarcane areas will be taken up.

Testing and Introduction of Varieties. A series of carefully conducted varietal tests have been in progress on the Central Farm at Bangalore for three years and the results indicate that at least one of the chief varieties grown in the State can be profitably replaced by an imported one, *viz.*, Red Mauritius. Small sugarcane seed farms are being established in suitable tracts this year for the purpose of introducing this variety. A similar series of varietal tests has been started on a new Experimental Farm at Marthur in the western part of the State where the rainfall is very heavy to obtain varieties suitable for introduction in that region.

Breeding Work. The conditions at Bangalore are so exceptionally favourable for the rearing of seedling canes that breeding work on a small scale was commenced two years ago. About two thousand seedlings are planted out each year, and while it is of course much too early to obtain definite results, indications are not wanting that we are likely to obtain strains decidedly more suitable to local conditions than any of the varieties either indigenous or imported which are at present being grown on the farm. Seedlings of Red Mauritius hold out special promise in vigour as well as in improved sucrose content. Some of these seedling strains will be ready for field tests next year.

Manufacture. The manufacture of sugar in Mysore is negligible so the remarks under the head are restricted to the manufacture of jaggery or *gur*. Work in connection with power crushing and the manufacture of jaggery on a fairly large scale has been taken up by the Department of Industries and Commerce; so, my remarks must be of a more or less general nature. A number of plants consisting of a three-roller mill run by an oil-engine and a battery of pans heated by an improved and very efficient type of begasse-burning furnace, devised by the Department of Industries and Commerce and already described by Mr. Chatterton, have been installed and the demand for such installations is likely to increase greatly in the future. At present two types of plants are being installed-a larger in which mills with rollers 12" by 18" are being used and a smaller in which 8" by 10" roller mills are installed. These installations have excited a great deal of interest in the State. In addition, a small steam boiling plant has been set up by Mr. Chatterton and is at present being tested.

The Department of Agriculture is engaged in introducing improvement in jaggery manufacture in smaller areas where a power plant cannot be profitably used. A considerable number of improved iron mills and improved boiling plants have been sold by the Department, while demonstrations of improvements in the actual manufacture of jaggery with the object of turning out a better product form an important item of departmental activity. In connection with the introduction of an efficient bullock mill the new Government workshops, recently established under the control of the Public Works Department, have commenced the manufacture of a type approved by the Agricultural Department, so that in the future the sale of these mills is likely to increase very greatly. They give an extraction from 5 per cent. to 10 per cent. more juice than the mills commonly used without any important increase of draught.

APPENDIX—E.

Subject XI.—Notes on Cattle-Breeding and Dairying.

(1)

(a)

Memorandum on a Scheme for Cattle-Breeding and Dairying in India.

(B. COVENTRY, C.I.E., *Agricultural Adviser to the Government of India.*)

INTRODUCTION.

The subjects of Cattle-Breeding and Dairying were considered by the Board of Agriculture at the Meeting held at Coimbatore in December, 1913, at which the following Resolutions were passed :—

"*Resolution No. II.*—That the Board endorse the report of the Committee appointed to consider the question of Cattle-Breeding and Food and Fodder-supply : the best means of investigating the relative feeding values of Indian cattle-foods, and agree that only general principles can be laid down in regard to (*a*) cattle-breeding, and (*b*) food and fodder-supply".

"With reference to the investigation of the relative values of Indian cattle-foods, they consider that a scientific investigation could only be carried out by a special staff with special equipment such as could not at present be justified by the comparative importance of the results likely to be obtained."

"*Resolution No. XV.*—That the Board endorse the recommendation of the Committee appointed to consider the question of the Dairy Industry in India that dairying as a branch of agricultural science should, in future, occupy a prominent place in the programmes of the Agricultural Departments."

"*Resolution No. XVI.*—That the Board accept the general principles enunciated in the report of the Committee appointed to consider the question of the Dairy Industry in India and desire to emphasize the importance of a satisfactory solution of the problem of the milk supply of towns, not only in itself but from the point of view of stopping the drain of good milch cows and buffaloes to the towns where they are not utilized for breeding purposes to the best advantage. The Board consider that some legislation is necessary."

Further discussions have since taken place between officers of the Agricultural Department and the Military Dairies from which it has been possible to make suggestions for a partial scheme for the improvement of Cattle-Breeding and Dairying, the details of which are set forth in this Memorandum.

Before, however, carrying the matter any further it is felt desirable that the Board of Agriculture should have an opportunity of discussing the details of the scheme. This memorandum has, therefore, been prepared with the view of placing the proposals before the next Meeting of the Board to be held at Pusa from the 7th to 12th of February, 1916.

2. A general policy for the improvement of Cattle-Breeding and Dairying, if it is to be complete and exhaustive, should include within its purview the following important items :—

(*a*) Measures for the protection and amelioration of the existing indigenous cattle-breeding industry, the preservation and multiplication of the existing fine types of Indian cattle, and the organization and regulation of breeding tracts.

(*b*) The preservation of grazing areas, the improvement of waste areas, and the general question of fodder supply.

(*c*) The improvement of Indian cattle by breeding and selection on a large scale for the production of pedigree stock with the object principally of increasing the yield of milk and the setting up of a good milch cow.

(*d*) Cross-breeding.

(*e*) The erection of model dairies throughout the country to aid (*c*) and (*d*), for obtaining milk records and for the spread of modern methods of dairying.

(*f*) The study and improvement of existing indigenous methods of treating milk and its products.

(*g*) The erection of dairy schools attached to dairies for training and education.

(*h*) The fostering of dairying as a business on commercial and co-operative lines for the supply of milk and milk products to the public.

(*i*) The application of sanitary control over the supply of milk and its products.

3. It will thus be seen that the improvement of Cattle-Breeding and Dairying in this country is a subject of great magnitude and economic importance requiring organization and the application of specialized knowledge. It is recognized too that it would be difficult to take up at once all the problems enumerated above and that it would be more satisfactory if a beginning were made in such items which it is thought can at present be suitably taken up. The scheme here suggested must, therefore, be understood to be incomplete and should only be looked upon as the nucleus of more expansive measures to be complemented chiefly by provincial effort. In what this effort should consist the views of the Board of Agriculture will be invited, but it is suggested that it could best be given effect to through the co-operation of the Provincial Departments of Agriculture, Co-operation, Veterinary and Sanitation.

4. As already mentioned specialized knowledge and organization would seem to be indispensable, and it is suggested that these could best be secured in the commencement by the appointment of an Imperial Expert Breeding and Dairying Officer to the Imperial Department of Agriculture with headquarters, say, at Kasauli, and whose chief functions might be as follows :—

(1) to organize and control special breeding and dairying operations more particularly those enumerated under (*c*), (*d*), (*e*), (*f*), (*g*) and (*h*) in paragraph 2 above ;

(2) to start and supervise dairy schools and dairy instruction ;

(3) to generally advise and assist Local Governments, Provincial Officers, Military Dairy Farms, Municipalities and private institutions on cattle-breeding and dairying including organization, improved methods, the erection of dairies, buildings, plant, marketing, training, etc.

In addition to the appointment of an Expert Breeding and Dairying Officer it is suggested that work on the value of food stuffs and the digestive capacity of Indian animals would be advisable as there is evidence of need of information on these subjects if feeding is to be done on the most economical lines. For this purpose the appointment of a Chemist is suggested. It is also considered necessary to adopt measures for the prevention of Rinderpest and other diseases amongst imported and cross-bred cattle owing to their high susceptibility to disease, and it is suggested that the co-operation of the Muktesar staff might be enlisted for this. It may also be found necessary to afford protection to all stock country-bred as well as half-bred.

The work under the proposed scheme might, therefore, be suitably divided under the following heads :—

A.—Cattle-Breeding.

B.—Dairying and Dairying Instruction.

C.—The determination of food values and of the digestive capacity of Indian animals.

D.—The Immunization of Cattle.

THE SCHEME.

A.—*Cattle-Breeding.*

It is not proposed under this head to provide for items (*a*) and (*b*) mentioned in paragraph 2 of this Memorandum. The protection of the existing indigenous cattle-breeding industry, the preservation of the existing fine types of Indian cattle and the general questions of fodder-supply and grazing are matters in no sense inferior in importance to those dealt with in the present scheme. But it is felt that they present problems of so local a character that the initiative is probably best left to Provincial Governments. There would, however, appear to be no objection if these were further discussed as the views of the Board would doubtless be of use to Local Governments.

The special aspect of cattle-breeding which it is proposed to deal with in this Memorandum and which is applicable to the scheme under consideration, is that mentioned under items (*c*) and (*d*) of paragraph 2 with a view of affording facilities to the Imperial Expert Breeding and Dairying Officer to carry out his functions (1) and (2). It is, therefore, suggested that the following special arrangements might be made with the Military Dairy Farms.

(*a*) The Imperial Expert to have for breeding purposes the use and control of the following herds of pure indigenous strains and with the concurrence of the Director, Military Dairies, powers of redistribution, and of adding to the herds, for the production of indigenous pedigree stock of good milking strains, the bulls of which would be distributed to Provincial Governments and approved institutions at a price.

Lahore-Ferozepore.—200 pure-bred Saniwals giving approximately 70 young bulls a year after three years for distribution in the Punjab.

Lucknow.—150 pure Hansis giving 50 young bulls a year for distribution in the United Provinces and Bihar.

Poona.—120 pure Scindhis giving 40 young bulls per annum for distribution in the Deccan.

Belgaum.—100 pure Scindhis giving 30 young bulls for distribution in South Deccan. (This farm may have to go out as it does not seem suitable for breeding).

Amballa.—120 pure Saniwals giving 40 young bulls for distribution in the Punjab and the United Provinces.

Jubbulpore.—100 Hansi-Hissar (Delhi type) giving 30 young bulls for distribution in the Central Provinces.

Quetta-Ruk.—120 pure Scindhis giving 40 young bulls for distribution.

No mention is made in the scheme for provision of bulls for Burma, Bengal, Assam and Madras, but it is understood that Military Farms may shortly be started one near Calcutta and one in Hyderabad (Deccan) from which bulls might be distributed to Bengal and Madras.

(*b*) *Cross-breeding* :—The Imperial Expert might have at his disposal also the two following Military Farms for the purpose of cross-breeding.

Amballa and Bangalore.—At each of these stations breeding experiments would be carried out in crossing with imported blood with the primary object of increasing the yield of milk. Incidentally too an endeavour might be made in the experiment to fix a type of dual-purpose animal suitable for the country. In this work the Veterinary staff at Muktesar would co-operate in rendering cross-bred cattle immune or resistant to disease. It may be found possible to extend this cross-breeding work to other farms.

(*c*) *Various Farms.*—Young selected buffalo-bulls of good strain 3½ years, to the number of 200 per annum might be supplied from various Military Farms for distribution.

There would be thus to commence with seven herds of pure indigenous strains aggregating 910 head from which an approximate return of 300 bulls of 3½ years' old per annum is estimated for distribution to provinces. There would also be an estimated return of 200 bull-buffaloes for the same purpose and a certain number of cross-breds.

It is further suggested that these bulls and bull-buffaloes should be handed over to Local Governments on payment and by them distributed, if possible, to selected Co-operative Societies who would be required to keep records. The best method of utilizing these bulls and the price to be charged is a matter for consideration, and discussion on this by the Board will be invited. Each bull is capable of serving a herd of 50 cows.

The cost of both cow and buffalo-bulls is estimated at Rs. 200 a head, but would be the actual cost of rearing, *i.e.*, food, housing, labour and actual incidental expenses, but not including administration or management charge, interest on capital, etc.

B.—*Dairying and Dairying Instruction.*

As one of the objects of this scheme is the building up of pedigree in dairy cattle, it is essential that breeding should be carried out at Dairies where a large number of cattle are kept and the quality and quantity of milk can be recorded. At all the farms mentioned above dairies are attached, and it is suggested that the Expert Breeding Officer might have the use of these for this purpose. It would also be necessary for him to undertake technical courses of instruction in dairying, in the introduction of improved methods of manufacture and in the handling of cattle. It is therefore proposed that at each of the following Military farms, *viz.*, at Bangalore, Poona and Lucknow a dairy school might be erected. At these schools a two years' course would be given to include practical dairying and handling of cattle with elementary scientific instruction in cognate subjects, the entries for which might be 20 students per annum.

There would also be Special Short Courses. Each school would be under the charge of a Farm Manager assisted by a Lecturer. Hostels, lecture rooms and laboratories would be provided. Admission would preferably be given to students nominated by Local Governments to whom stipends would be given. Certificates would be granted on satisfactory completion of the course.

C.—*The Determination of Food values and of the Digestive capacity of Indian Animals.*

For this the employment of a Chemist would be necessary for—

(*a*) the estimation of the value of Indian feeding stuffs by analysis,

(*b*) ascertaining the relative digestive capacity of cattle and buffaloes,

(*c*) practical feeding experiments, and

(*d*) the determining of individual values *ab initio* by respirator chamber.

(*a*) and (*b*) might be taken up at once at Pusa where the Chemist would be posted and provided with cattle and buffaloes.

(*c*) would be an extension of (*a*) and (*b*) and could be carried out both at Pusa and the Military Dairy Farms while (*d*) might for the present be delayed.

D.—*The Immunization of Cattle and Co-operation of the Muktesar Staff.*

As already pointed out it is considered absolutely necessary to adopt measures in the Military farms for the prevention of Rinderpest and other diseases amongst improved and cross-bred cattle owing to their high susceptibility to disease. It may also be necessary to give protection to all stock country-bred as well as half-bred. It is suggested that the Muktesar staff should undertake this work.

APPENDIX.

Budget.

An attempt has been made to give below an approximate cost (capital and recurring) of the scheme suggested in this memorandum. It is estimated that the cost would be roughly as follows :—

CAPITAL.

	Rs.
3 Diary Schools each with lecture room and laboratory for 40 students at Rs. 9,000	27,000
3 Residences attached to the Dairy Schools for Farm Managers attached to Dairy Schools at Rs. 10,000	30,000
3 Residences attached to Farms for breeding operations at Rs. 10,000	30,000
3 Hostels attached to Dairy Schools with quarters for Lecturers at Rs. 22,000	66,000
Furniture for Dairy Schools	5,000
Purchase of buffaloes at Pusa for the Chemist	5,000
Residence of Chemist	20,000
Laboratory and furniture for Chemist	12,000
Cattle sheds and weigh bridge for Chemist	3,000
	1,98,000

RECURRING EXPENDITURE.

Imperial Breeding and Dairy Expert—

	Rs.
Pay of officer Rs. 1,500	18,000
Clerical establishment (5) :—	5,220
1 (100—10—150), average 137½	
2 (75—5—100), average 187½	
2 (40—4—60), average 110	
Menials (4) 1 (10), 3 (8), average 34	408
Travelling allowance	3,000
Contingencies	1,500
	28,128

Dairy Schools—

	Rs.
Farm Manager on a time scale of Rs. 200 rising to Rs. 700 (average 405 + charge allowance Rs. 50)	5,460
Lecturer (150—30—300) average Rs. 250 + Hostel allowance Rs. 50	3,600
Allowance to Farm staff Rs. 100	1,200
Servants 2 (8)	192
Contingencies	1,000
	11,452
	× 3 = 34,356

Breeding—

Additional cost thrown on the following Military Farms on account of breeding operations :—

	Rs
Lahore-Ferozpore	10,500
Lucknow	11,250
Poona	9,000
Belgaum	7,500
Amballa	9,000
Jubbulpore	7,500
Quetta-Ruk	10,000
Bangalore (cross-breeding)	2,500
Amballa (cross-breeding)	2,500
Approximate cost of rearing 500 bulls at Rs. 200. This amount will be recovered by sale of bulls)	1,00,000
Extra supervision of 3 Farm Managers for breeding operations on a time scale of Rs. 200 rising to Rs. 700 or average Rs. 405 + Rs. 50 allowance	16,380
	1,86,130

Chemist—

	Rs.
Salary (800 + 100 local allowance)	10,800
2 Assistants (150—10—200) average 366⅔	4,400
4 Servants 1 (10, 3(8), average 34	408
Travelling allowance	1,000
Contingencies	1,000
Supplies and Services	2,000
Feed and keep of cattle	1,000
	20,608

Abstract of Recurring Expenditure—

	Rs.
Imperial Officer	28,128
Dairy Schools	34,356
Breeding	1,86,130
Chemist	20,608
	2,69,222

(b)

Notes on the Recommendations of the Board of Agriculture in India, 1913, regarding the Dairy Industry of India.

(S. Milligan, M. A., B.Sc., *Imperial Agriculturist.*)

I do not think it is necessary to emphasize the importance of the subject. This has been done by the Dairy Committee of the Board of Agriculture. The chief point to be noticed is that dairying from the general point of view is the most important of all agricultural questions in India for the following reasons:—

Its general application to the whole country.

Its close connection with the supply of draught animals.

The great suitability of dairying to the Co-operative movement.

The present disorganized and degraded state of the industry and the great possibility of improvement.

The improvement of dairying in most countries has been effected through:—

(1) The improvement of the milking qualities of the dairy animals.

(2) *Technical courses of instruction in dairying and the introduction of improved methods of manufacture.*

(3) The organization of the commercial side of the industry.

It would therefore appear convenient for the sake of discussion to group the recommendations of the Board of Agriculture as follows:—

I. Breeding. II. Instruction

III. *Organization.*

I. *Cattle-breeding.* The Board laid great stress on the point of view that the production of a dual purpose animal should be the aim of all Government Cattle-breeding operations in India.

Breeding of Plough Cattle. Up to the present time cattle-breeding has been conducted to a large extent in definite grazing tracts by nomadic tribes. The extension of arable cultivation, involving a decrease of these breeding areas and an increased demand for plough cattle, has resulted in a scarcity in the supply of such animals. It is now generally recognized that this deficiency will have to be met from breeding in the arable tracts. The cost of breeding in such tracts will necessarily be high owing to the competition of cropping and the good prices which are now generally obtainable throughout the country for the produce of field crops. If, however, cow-keeping could be made profitable there would be at once a large number of young bulls for rearing for draught purposes. The supply of plough cattle would therefore be automatically increased incidental to the establishment of cow-keeping as an industry.

It appears therefore a sounder policy for Government to attack the question of the supply of plough cattle through the improvement of the milking qualities of the breeds rather than to trust that the increasing prices of draught bullocks will induce the cultivating classes to go in for breeding.

Dual purpose animals. On the other hand it would be undoubtedly an advantage if the introduction of improved milking powers could be combined with good draught qualities. From a broad point of view, therefore the ideal policy to meet the present situation would be the introduction into the arable tracts of cattle bearing the two qualities of milk and draught. In some quarters there exists an idea (probably derived from the no doubt correct opinion that flesh producing and milking qualities are antagonistic and cannot be produced in the same animal) that a dual purpose animal for milk and draught is unobtainable. Such is not the case as has been proved both by experience and by crossing experiments; for, although the present breeds of cattle in India have on the whole developed such distinctive characteristics as to be classed as milk and draught breeds, individuals carrying both characters are to be met with, and the successful experiment made by the Military Dairies in mating Montgomery cows with Ayrshire bulls has produced females with excellent milking qualities and males of exceptional draught powers. *It is thus obvious that the two characters are by no means incompatible. It appears to me to be quite* clear that the ultimate objective of Government policy with regard to cattle-breeding should be the establishment of herds of such dual purpose animals and the distribution in the cultivating districts of bulls carrying both qualities. Such a policy would moreover, be readily appreciated and welcomed by the people.

Dairy Farms essential to the breeding of Dairy animals. It has been the experience of other countries that the best and in fact the only satisfactory method of building up pedigree in dairy cattle is by the careful recording of the actual quantities and qualities of milk of the cows and by using bulls from only the best milkers. This means in effect that breeding for milking qualities can be carried out most economically in dairies, as any attempt to keep milk records of a large number of cows without selling at least a part of the produce would end in heavy financial loss.

P

Large herds necessary. Another point and one of no less importance is that the establishment of pedigree can only be safely attempted by operations on a large scale. Success will depend on the production of male animals pure in the Mendelian sense in the desired characters. In small herds this achievement is in effect a matter of luck but given a sufficiently large herd of animals, the fixing of the qualities aimed at is a matter of time and careful experiment.

Crossing for the sake of obtaining milk pedigree. It is also essential that any breeding operations should rest on as broad a basis as possible and that they should therefore not necessarily be restricted to the mating of country cattle of the same breed. On the contrary experimental crossings with a view to fixing new types should form part of any comprehensive scheme of cattle breeding.

Dairy Breeds. Although the general average of efficiency of the milk animals in India is low there are three breeds of cows and one of buffaloes of which individuals giving high yields, although scarce, are still to be obtained. These are the Hansi-Hissar, the Sindi and the Sanhiwall (Montgomery) cattle, and the Delhi strain of buffaloes. The two former could by persistent selection be graded up into dual-purpose breeds, the Sanhiwal bullocks are slow but the cows thrive well over the whole of India and mate well with imported stock. The Delhi buffalo is worth breeding for the *ghee* and butter making tracts. The remaining breeds of Indian cattle are practically useless as a basis for milk production except possibly for supplying female parents for crossing purposes. I would therefore recommend that pure strains of high yielding milk cattle of the above breeds be established and that experimental crossing with imported pedigree milk breeds be undertaken *by Government.*

In order to carry out a scheme of this kind, the co-operation of the Military Dairy Farms Department would be invaluable. At the Coimbatore Conference the Director of Grass and Dairy Farms indicated that his Department would gladly assist in the direction of instruction and experiment, and I have no doubt he would readily extend his support in dealing with breeding questions. Subject to the approval of his Director, Mr. Smith, Assistant Director, Dairy Farms, Southern Circle, suggests the following distribution of the Military Dairy herds to suit pedigree breedings. The scheme is suitable in every way from the Civil point of view and if it can be carried through would ultimately be of great value to the country :—

Indian Breeds, etc.

Mr. Smith's scheme of distribution.

(1) Military Dairy Farms, at Lahore and Ferozepur already have herds of Sanhiwal cows which are probably equal in milk production to any herds of Indian cows. As the herd improves the bulls could be reared for distribution.

(2) With the concurrence of the Military Farms authorities a herd of pure Hansi-Hissar cattle to be established at say Lucknow Farm. This herd to be formed of say the best 100 Hansi-Hissar cows from the Military Dairy Farms at Agra, Cawnpore, Allahabad and Lucknow. All the bulls from these animals could be reared and distributed and the quality of the herd gradually graded up by careful selection. This herd could be expanded as the demand for bulls increased.

(3) A pure-bred herd of Sind cows could be established at the Government Dairy Farm, Ruk Junction in Sind, composed of say the 100 best milkers of the Sind breed at the Government Farms at Ruk, Quetta. As this breed already has some qualities in the direction of both draught and milk, the bulls from the outset can be carefully reared and distributed and the herd gradually increased and graded up.

(4) At Belgaum Military Dairy a pure Sind herd should also be found composed of say all the Sindi cows at the Military Dairies at Poona and Belgaum giving over 2,500 lbs. per annum. Bulls to be carefully reared and distributed and the herd to be gradually increased and improved.

(5) At Amballa, Jubbulpur, Poona and Bangalore experiments would be made in crossing Indian stock with imported bulls of the milking strains and distributing the half bred bullocks, after castration and immunization against rinderpest by simultaneous inoculation, to all the Civil Government Farms under the Agricultural Department in India with a view to testing the working qualities of the cross-bred cattle.

Experiments would also be made along Mendelian lines at all these Farms in crossing half-breds got from imported bulls with a view to fixing types and characters, particularly draught and milking qualities and immunity from the common epidemic disease of the country.

(6) At all the Military Dairy Farms in India whether used as training centres or otherwise buffalo bulls of good class milking strain could be reared and made available for distribution.

All bulls reared by Military Dairy Farms for distribution would be purchased by the Agricultural Department at a fair price.

There remains the question of grading up the remaining breeds of cattle in the country. This is essentially a Provincial question. In many parts of the country there are practically no properly typed breeds and in others the recognized breeds are scarcely worth dealing with. The Military Dairies can of course deal only with the more profitable dairy breeds, and to complete the scheme the Provincial Agricultural Departments might, at some of their most suitable Agricultural Stations, make an effort to deal with any local breeds which may be considered worth while working up or produce new breeds by crossing. This is a class of useful and interesting work for the carrying out of which the majority of our Deputy Directors of Agriculture are well qualified.

It is proposed that Pusa which has great facilities for this class of work should take a leading part in experimental crossing along Mendelian lines.

Milk Record Societies. A necessary part of a breeding scheme would be the formation throughout the country of *milk-recording*, preferably through societies. It is quite necessary owing to the limited number of pedigreed bulls which can possibly be turned out from Government Farms that these bulls should be mated with the best cows so as to increase the number of *reliable* bulls in the country. In fact the process of pedigree building will have to be repeated in the Districts. There will, however, be this great difference that whereas Government must start without any pedigree, the village societies would begin with the great advantage of having pedigreed sires.

Instruction : Dairy Schools. The Board of Agriculture recommend that "a dairy school should be opened in each Province at some important dairy centre for the training of persons who propose to engage in dairying" and there is no doubt but that something of this sort is very desirable.

To establish six properly equipped dairy schools with land and buildings complete in the Punjab, the United Provinces, Bengal, the Central Provinces, Bombay, and Madras would cost say 18 to 20 lakhs of rupees and it would take a considerable time to build and equip these centres and to find men suitable to run them.

The Military authorities at the present moment have well equipped and carefully managed dairy farms at the following stations :—

Peshawar-Cherat, Rawalpindi-Murree, Lahore, Dalhousie, Ferozepur, Jullundur, Sialkot, Karnal, Agra, Lucknow, Allahabad, Cawnpore, Jubbulpore, Mhow, Quetta-Ruk, Poona, Ahmedabad, Belgaum, Bangalore, Aden.

At the Coimbatore Conference the Director of Military Farms at Army Headquarters stated that he thought his Department would be willing to co-operate with the Civil Agricultural Department in permitting the Military Dairies to be used as educational and experimental centres. The more important of the Military Dairies have large herds, they are equipped with the most modern and up to date plant including refrigerating machinery, they cultivate considerable areas solely for the purpose of growing fodder for milk production. They have a trained and experienced staff of practical managers, a modern system of commercial accounts, a large turnover and are run on strictly commercial lines, all of which are essential in a modern dairy school: so that the problem of the establishment of dairy schools in most tracts can be immediately and cheaply solved by co-operation with the Military Farms authorities. *It is suggested that the following Military Dairies* might be utilized as training centres:—

Peshawar (for the North-West Frontier).

Amballa (for the Punjab).

Lucknow (for the United Provinces and Bihar and Orissa).

Jubbulpur (for the Central Provinces).

Poona (for Bombay Presidency).

Bangalore (for Madras Presidency).

Quetta-Rnk (for Sind and Baluchistan.)

To commence with Bengali studeots might be sent to Lucknow Farm but later on as circumstances permitted a school with the necessary land could be set up in the vicinity of Calcutta to which city the produce could be railed and sold.

The Military Dairy Farms have butter factories at Peshawar, Amballa and Ahmedabad, and as a thorough course of practical dairy instructions should include a factory course where produce is handled in bulk (the Ahmedabad Factory manufactures 1 ton butter per day in the busy season), students from Northern India could be sent to Peshawar and Amballa and from Southern India to Ahmedabad for this special class of training.

The cost of carrying out working experiments in connection with dairy problems at the Military Dairy training schools cannot at present be accurately stated, as it would depend upon the work to be done. The cost of such work could, however, be estimated for separately and budgetted for annually when definite experiments were decided upon. For teaching, however, it may be taken that for the first year or two the only expense necessary would be the cost of an extra trained manager at each of the training schools. This would work out at Rs. 6,000 per school per annum including Rs. 500 per centre for travelling expenses and Rs. 500 per school per extra apparatus, chemicals, etc. Travelling allowance is necessary as the teacher might require to accompany the pupils to and from the butter factory and extra testing and minor experiments would require to be carried out for the benefit of the students over and above the ordinary work expenses. In the off season, when students were not under training on any farm, the specially trained manager would be occupied in compiling records and preparing for the next class.

When the scheme developed it might be advisable to provide quarters for Indian students at the schools, but until the system has proved a success temporary arrangements could be made.

Organization. There remains a very large and important question of organization under which may be grouped recommendations (c), (d), (e), (f), (g), (h), (i) of the Conference.

Although Cattle-breeding and Education may be considered fundamental or preliminary necessities in the improvement in Dairying, the carrying out of a general advance throughout the country can only be attempted through an efficient organization.

The co-operative movement working under the guidance of the Agricultural Department can, it seems to me solve this difficult problem.

The distribution of pedigree bulls, the establishment of milk records, the spread of knowledge amongst the people, the organization of dairy concerns and the marketing of dairy produce can be best done through Co-operative Societies.

It seems quite clear that at the outset all dairying concerns, co-operative or otherwise, will stand in need of sound advice and assistance which should be forthcoming from the Agricultural Department. They will, in fact, require an organizing head.

Now it is extremely doubtful if the Agricultural Department can, as at present constituted, supply this want. Our men are not only busily engaged in current work, but even those of us who have had practical dairy experience at home have been too long away from the work to be able to advise and organize.

No doubt the final organization of the Provincial Agricultural Departments will contain a Dairy Expert for organising and advising on Dairy matters. This is at present however impracticable as the demands of the provinces for men to carry on existing work have not yet been met.

In the circumstances the best plan seems to be the appointment of a Dairy Expert to the Imperial staff of the Agricultural Department. Without some such appointment, there will not be much material progress made in Dairying for a long time to come. There is already urgent need for a man to advise Municipalities and to take a lead in organizing milk supplies for the large cities. There is sufficient justification for an Imperial appointment from this point of view alone. There is, in addition, the whole question of the organization of milk record societies, of co-operative selling and the general development of the Industry.

Scientific Investigation. Although the ultimate importance of scientific research is undeniable, it will not be until dairying has made a real advance that the problems requiring attention will emerge. This advance will be made through breeding, education and organization. Research, therefore, can be said at present to be of secondary importance and it would be a pity to waste the time and money on buildings and on extra staff such as has been proposed in the dairy scheme for Pusa until the industry has developed. The problems suggested by the Board as being at present worth investigating are—

(a) How to best sterilize milk in India.

(b) How to make a good starter for ripening buffalo cream.

(c) What a percentage of buffalo fat cream should contain to produce the best results in ripening.

(d) How to milk cows without the presence of their calves.

These suggestions should not require the establishment of a dairy at Pusa, which would almost to a certainty be run at a loss, and it ought to be possible to solve them by working on a laboratory scale.

Legislation. The Coimbatore Conference recommended "that legislative measures against the adulteration of milk should be taken to protect honest traders and to encourage capitalists and co-operative societies to invest money in the dairy industry." There is no doubt whatever, but that the present unchecked system of wholesale adulteration of milk and *ghee* affects the producer and consumer with equal severity. It hits the productive side of the industry most in that it keeps honest men out of the trade and it debars capitalist, whether troubled with scruples as to commercial honesty or otherwise, from investing money in a business where the produce may be adulterated to an unlimited extent by their competitors. These evils do not exist in many other trades, such as textiles or hardware, the comparative purity of which cannot be tampered with.

The great European Tinned Milk Companies are making fortunes out of sterilized natural milk imported into India and sold at prices ranging from 4 to 7 annas per lb., whereas the actual cost of production of pure cow's milk should not exceed two annas in any part of the country. Indian dairy produce has got such a bad name, and de-

servedly so, that the educated Indian in many cases pays 400 per cent. more for tinned sterilized milk rather than use the home product. Two instances have recently come to my notice where reliable business men with the necessary capital were willing to embark on a dairy enterprise, but were so disgusted with the adulteration which they would have to compete with that they abandoned the idea.

It is probable that legislation alone would not provide the remedy, but it would certainly check that evil.

Railway Freights. The reference made by the Board to the cheapening of rail charges is of great importance especially in connection with the supply of fresh milk to the large cities. Fifty years ago the milk supply of London, Paris, Berlin and other large cities was drawn from cows located either in these cities or on their immediate outskirts: to-day these towns are supplied from a radius of 400 to 500 miles. The same economical forces which have brought about this change in Europe will probably produce a similar result in our larger cities. This desirable change could be greatly encouraged by a reduction of the Indian rail charges for milk. If the milk supply of Calcutta, Bombay, Madras and Karachi is to be produced at the lowest possible cost and under sanitary conditions it must be from cows located where fodder can be grown and where land for housing and exercising can be had at its agricultural value.

Indian railways carry milk at half parcel rates including weight of cans which for distances over 50 miles is something like 100 per cent. higher than the current rates of English railways for carriage of milk by passenger trains. Many of the railway companies have already given concessions to the Military Dairy Farms, and it is likely there would be no great difficulty in getting these extended to the general public in the case of the lines feeding the larger cities.

Summarising I would recommend the following policy with regard to dairying.

(i) *Organization.*—For the sake of initiating a movement for the improvement of Dairying in India the dissemination of sound advice to public bodies such as Municipalities, Dairying Companies, Co-operative Societies and Education on dairy matters the appointment of an Imperial Dairy Expert is necessary.

(ii) *Breeding.*—(*a*) The securing of the assistance of the Military Dairies and all Government Dairy Farms in building up by selection and crossing, milk pedigree combined if possible with draught qualities.

(*b*) The formation of milk record societies in the districts for continuing and developing the work on Government Farms.

(*c*) That owing to its favourable situation, Pusa should take a strong lead in initiating experimental work and co-ordinating results obtained elsewhere.

(iii) *Education.*—The co-operation of Military Dairy Department.

(iv) *Legislation.*—Subsidiary points are :—

Legislation which must be left to the Legal Advisers of Government.

(v) *Railway rates.*—The Railway Companies, if approached, would no doubt extend the concessions given to the Military Dairies.

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(2)

BENGAL.

(A. D. McGregor, *Superintendent, Civil Vety. Dept., Bengal*).

The very intimate relationship existing between *Cattle-Breeding* and *Dairying* for consideration, would tend one at a glance to the opinion that they might be more adequately discussed under the one head, *Cattle-Breeding* with special reference to its *Control and Dairying*; but although so closely bound up in each other, in that the common and ultimate object is, the progressive improvement of cattle in general, I venture to take the permission of discussing them under one *comprehensive head* "*Cattle-Breeding*" and the *two minor heads, Intensive and Extensive*. This will enable me to describe in a general manner, methods of improvement of cows and bulls, while under model conditions, as on farms (*intensive*), and methods under conditions other than these, as in the mufussil (*extensive*).

Cattle-Breeding.

The stage so near to perfection to which the best Home Breeds have reached, can scarcely be improved upon and undoubtedly now-a-days, the chief aim of the owners or breeder is to more and more definitely stamp and transfix, in the cows and bulls, those qualities they may possess, or may have reputation for, as a breed, so that they may be passed on to their progeny, and become, in time, established as hereditary ones. Concomitant with the object of transmission of good points from one generation to the next, the very serious subject of *hereditary disease* and inbreeding with their resultant ravages in a herd, receives profound consideration from the breeders. The subtle difficulties to be overcome in dealing with *heredity*, the keen foresight and untiring energy necessary for the proper control of its disease, of its aids and hindrances are beyond dispute. Finally the work entailed in the attempted realization of all the aims and hopes of the breeder must obviously spread over a space of years, so that progress in the improvement of any cattle, in any country, from any one type of cattle to another, takes time and patience; the length of time depending, to a great extent, on the type in view and how far that "*view type*" is removed from the original or "*foundation type*." This leads one to the very important fact, that, once started, with a type (or its closest relation), which will be the foundation of the ultimate best one can expect by breeding from that type, then one's whole energy should be directed to giving force to a definite method or system whereby the two most salient factors in breeding would come under proper control. These are :—

1. *Heredity.* The part played by it in the transmission of *good points and defects*.

2. *Disease.* Hereditary predispositions, epizootic diseases and others.

A. Intensive Breeding. This refers to that part of breeding to be done on Government farms on which special types of cattle would be retained for the sole purpose of being bred from, along methodical lines. The overseers in charge would require to know exactly the course of the method or system to be followed on these farms. The farms would not be so large, but that the man in charge would be able to personally attend to, each day, all matters concerning the mating of cows and bulls, calving of cows, feeding and general rearing of the calves; and not so small as to lower the value of the farm as a model or example or as a future depôt to the district.

To my mind there are only three practicable ways for the improvement of Bengal cattle open to us, and these are :—

I. *Improvement* through the *medium of entirely Deshi Cattle*. II. By *Importation* of *Bulls*. III. By *Importation of Cows*.

I. *Deshi Cattle.* In Bengal we are severely handicapped from the very beginning. The finding, the choosing, the picking out from the multifarious types to be found in Bengal, and the laying down of one or two or more of the best of these (males and females) as foundations upon which to gradually build a really good type of cattle is

an arduous task ; but at the same time such a procedure or method of improvement *must* result in a definite (if slow) betterment of the types originally begun with. All the factors, hereditary and others, coming into play, would require discriminate help and control where possible ; strict attention to feeding and general hygiene, followed by judicious retention of good stock, and elimination of bad. *Under these circumstances the results must eventually lead to improvement of deshi cattle.* This system or its modification has been tried and is at present going on. It is undoubtedly slow, and for that reason only, does not commend itself to most people ; but it has many outstanding *points in its favour, and the work in this direction that has already been done, cannot be criticized, far less judged*, as to results, in the space of a few years.

Advantage. The outstanding and determining reasons in favour of breeding initially from entirely *deshi* cattle are rather indirect than direct or immediate. Generally speaking, the cows are small with dwarfed udders, bulls defective and varied in type, both tending to the production of indifferent stock ; but the very solid fact, that they have been indelibly *stamped, gradually and naturally through years of exposure to the severe conditions of climate* and disease in Bengal, with an *inherent hardihood* ; an accumulated power of resistance to excessive *heat, wet, scarcity of pasture* and at the same time possess only a small degree of susceptibility (as compared to others) to the prevailing *diseases.* These are qualifications not to be overlooked in deciding upon the best system of improvement for cattle in this country.

II. *Importation of Bulls.* With strict reference to Bengal, *the importation of bulls might be said to include* those brought in from the other provinces of India, and those directly imported from countries other than India, as the British Isles, Australia, Newzealand, etc. My experience of bulls of the former class, that is, provincial bulls, *is unfortunately too meagre* to permit of my discussing them ; but according to literature on the subject, the ideas extolled differ greatly, and are frequently of such a conflicting character, that a concensus of opinion as to which are the best bulls to import, is difficult to procure. The majority of bulls likely to be imported from the Provinces, would, I should think, be of a much larger and heavier type, than *deshi* cattle. This would necessitate great care and discrimination in mating, so as to avoid the almost certain dangers to be incurred by the cows during service (from excessive weight of the bulls), and *later on*, during parturition (from the extreme size of the calves). This feature of suitability of bull to cow, would be a serious problem in a scheme for the importation of provincial bulls. With reference to the importation of bulls of British breeds, the great expense necessarily involved in the primary *purchase of same, the work of acclimatisation and the immediate risk to be run from the possibility of their suc*cumbing to the diseases of this country, ere they had justified their existence as bulls do not incline one to favour this line of improvement being taken up extensively enough to do any real good.

III. *Importation of cows.* This system must at the outset be put down merely as an alternative to the method of importation of bulls. The direct expense in purchase as compared with bulls is multiple (due to the large number required) as also are the risks run. *This system could only obtain on farm breeding stations with a view to rapid* production of a few good stud bulls out of reputed milch cows. These might give good results. Theoretically it would appear, it should work out fairly soon to an improved strain of milker (imported cows having necessarily *been of good milking class*), the progeny growing up possessing the natural hardihood of the *deshi.*

The system of improvement by the proper selection of and breeding from *deshi cattle, without importation of bulls* or cows, being less expensive and therefore more likely to be continued for *many years* ; the sphere of choice of bulls and cows suitable to one another and more suitable as to type being unlimited ; and finally because so much time and energy have already been spent in this direction I feel sure the scale of argument in favour of the continuance of such a method must outweigh that against it.

Farms. One in each of the districts of Bengal would, of course, be necessary for the thorough working of any scheme of improvement. In selecting the sites for such farms, attention would *require to be given to the question of Elevation, Soil, Water Supply* and *Pasture.* A combination of the best of the above items is what is wanted.

Taking for granted the various breeding farms have been decided upon as to site, etc., the following administrative points should be noted. *Firstly.* They should be central in position as regards the district they are intended *to influence and affect. Secondly. They should be under proper control and supervision, with methodical lines* laid down, along which the mating, rearing of calves, dietetics and general hygiene of the whole concern will be run.

Whether the system be *improving from entirely deshi cattle or by importation*, the same attention and importance to the above-mentioned points must be given and adhered to, once the farm is started, and in my opinion only *one system of improvement* should be attempted on one farm, and not a mixture of two or three.

A few details on Breeding. A few minor points need only be mentioned here, to definitely show how important and, in fact, absolutely necessary it is to have in charge of these farms *a man who is thoroughly acquainted with* at least the elements of the principles of breeding. (*a*) The age at which a cow or (to be correct) a heifer is mature and capable of conceiving, if served by a bull during œstrum or heat, is generally admitted to appear before the heifer has attained her full physical development, but is liable to variation, depending to a great extent on food, climate and other circumstances. This state of maturity varies in its appearance in the heifer from the ages *of 12 to 18 months*, and is evidenced by certain symptoms, collectively called "Œstrum" or "Heat." These symptoms must be well known to the breeder, so that he may catch the cow on first evidence of œstrum and have her served by the appropriate bull, provided he is of opinion she has developed sufficiently well and is in an otherwise fit condition to justify his doing so. The difficulties of *breeding from aged animals or from cows from 3 to 4 years* of age, that have not previously been used for Stud are well known, but even so it seems to be the prevailing idea in this country to utterly neglect putting the cow to the bull, until she is 3 to 3½ years of age.

This practice on farms would naturally be disastrous both from a monetary and breeding point of view. Many of the heifers thus neglected would lose their *fertility* or their *aptitude to procreate*, and would therefore remain barren for life or give rise to serious trouble in *attempting to make them conceive ; so many years of the cow's milk*ing life would be blank, with the hope gone of ever making anything of her as a *milch cow.* Recognizing the fact that up to 3 to 3½ years of age, a cow should have given birth to at least one, and even two calves, one must admit that neglect in taking advantage of the early periods of œstrum in heifers, most seriously affects the farm as a breeding station. The number of calves born is lowered, the development of the udders retarded, quantity of milk produced lessened, and as I have said before, the possibility existing of the cows' powers to conceive destroyed. A reason for this oversight may be, that, on the heifers' first reaching maturity, the œstral periods are frequently of no longer duration than 24 hours, and to see the symptoms at all, a very close inspection of the heifers at this age is absolutely necessary.

(*b*) Another salient point in breeding is that no time should be lost in having the cow served by the bull as soon as possible after parturition. The cow will comulate with great certainty of success on the 9th to 10th day after giving birth to a calf, but *she will seldom do so if suckling that calf.*

Should that period be missed, or if the cow be served but does not conceive reappearance of œstrum may be noted every month or three weeks or at shorter intervals during the breeding season, peculiar to that particular cow. This periodicity is regulated by nature with a view to preservation of the species ; and in animals not influenced by artificial conditions it is so arranged that the young may be born during the season when their maintenance may be best assured. An environment of domesticity with the mere assurance of food and shelter undoubtedly multiplies the periodical returns of œstrum, so that it is not too much to expect, that thoroughly improved conditions of feeding and housing with *facilities for parturition and the rearing* of the young, will still more affect maturity and œstral periods in this way. The calves would require to be taken from the cows something like 24 hours after birth and the cows milked and the calves fed by hand, in order to prevent the likelihood of the cows not coming into heat, or refusing the bull on the 10th day. It would not be a difficult matter for an intelligent manager of a farm to teach these and other duties to the native servants, but the supervision of their work and of such mattres as the quantity of milk got from the cow and the quantity given to the calves, would entail most of the trouble to be encountered in this sphere of the work.

B. Extensive Breeding. This covers all work done in the *mofussil* respecting improvement of bulls and cow and their progeny.

The work in this direction which has been done and which is being continued in an amended or extended form is that of *advice* concerning improved methods of breeding given by the itinerant veterinary assistants of this department, to the ryots and others in their respective districts. This accompanied by the free distribution of pamphlets on *Prevention of Disease*, having gone on for several years, must have been and no doubt is helpful; but the great difficulty of ascertaining the extent of good done, is the stumbling block to the advisability of expanding this process.

The whole work of the Department is indirectly, a means to an end in this respect, as in most outbreaks of disease, the weak as a rule go to the wall and the *strong, the robust, the best of their type* generally survive sufficiently long to admit of treatment and recovery.

Again, the work of selecting suitable bulls from over the province, and distribution of them to the various jails and District Boards, is being continued as far as possible, and it would appear from the increased demand for such Bulls that this system is becoming popular with the people and, being inexpensive, is likely to be beneficial in the end.

However, the fact that the demand for bulls of good type is on the increase, only the more glaringly displayed their paucity or at least the scarcity of them in the better known districts and railway vicinities, all pointing to the pressing necessity for extensive search of the whole province and a more intimate one of the better known grazing tracts for such bulls (and cows), and the eventual setting up of farms as breeding stations.

Other means of improving the mofussil cattle might be tried but would, of course, be mere side-issues, as are the above, without the inestimable support of, so to speak, the *Alma Mater* to all breeding *the farm*. Young bull calves of good type can more easily be procured than good bulls of a mature age, simply because of the neglect in feeding and shelter given to these calves during the growing periods of their lives, and as a matter of course with resultant deterioration. The bull calves selected could be bought in numbers and set down in the farms to be properly reared and looked after till mature and then distributed throughout the districts. A procedure subordinate to that of the establishment of farms but which would require to be run on parallel lines would be the laying down of selected cattle on good grazing tracts, near the hills or in other districts. This would necessitate the work being done on a large scale, as these grazing tracts are no doubt few in number and such a scheme without district farms would be the only source from which to supply the whole province with improved stock.

Generalising on the whole problem, I wish to repeat that the great length of time which must necessarily pass before any positive sign of improvement can be observed on any breeding station, whatsoever, is frequently the cause of many adverse reports and criticisms being made as to results on such work. The controller of these stations must, of necessity, ask for, even request or demand criticism; but criticism to my mind can be of two kinds: it can be of a constructive nature, enlightening the difficulties and reducing the defects, of the person or thing criticised. It can also be in the shape of a denunciation, sterile and depressing, leading to a mere impasse or *cul-de-sac*, from which no forward movement can be taken.

Obviously the kind requested is of the former standard, and in no sphere of work in agriculture is encouragement and incentive to keep going on, more essential than that of cattle breeding.

In conclusion I should like to say, the above few words, naturally, do not aspire to bring the nucleus of any prescribed scheme on the subject or in any way do they even pretend, to form an adequate reply to the very exhaustive questions put up for discussion, but are merely a few suggestions put down hurriedly as they occurred to me. No doubt many of the ideas set forth have already been recorded, but a repetition of them will do no harm, and my inability to get hold of and read all the literature on "Cattle Breeding in Bengal," is my misfortune and at the same time the cause of any plagiarism on my part.

(3)

BIHAR AND ORISSA.

(a)

(G. MILNE, I.C.S., *Director of Agriculture, Bihar and Orissa.*)

As long ago as 1902, the question of the preservation and improvement of cattle by the organization of a cattle-breeding farm engaged the attention of the Government of Bengal which decided to form at Pusa a herd of *deshi* cattle carefully selected from among the best bred draught and milking cattle in Bihar. A scheme was worked out by the Director of Agriculture in consultation with the Inspector-General of Agriculture and of the Veterinary Department and was adopted and carried out by the Imperial officers after the Imperial Agricultural Research Station and Institute had been sanctioned and brought into being. The scheme aimed at establishing a herd of 200 animals true to the type which seems most suitable for Bihar with the object of breeding for the plough and for draught. Eventually about 50 cows and one bull were purchased in Bihar mostly in the Shahabad and Ballia *diaras* and breeding operations were continued until 1909. By that time the opinion had gained ground that the Research Institute's resources were over-taxed in maintaining this *deshi* herd as well as a Montgomery herd which had been collected there with a view to the rescue of that breed from rapid extinction and also to the improvement of the breed by selection. The area of the Pusa Estate was found to be somewhat small for the proper development of both herds and a proposal of the Government of Bengal to subsidize the *deshi* herd had not materialized. It was, therefore, arranged that the *deshi* herd amounting now to 92 head of cattle after rigid rejection of defective young stock should be made over unconditionally to the Bettiah Raj Estate under the management of the Court of Wards. The herd was transferred to Bettiah in 1910 and after various vicissitudes is now doing very well. At the present time after the distribution of a number of bulls it consists of about 140 head. The bulls have hitherto been placed principally in charge of Managers of Factories who are tenants of the Raj and who allow the free use of the bulls to any *raiyats* that desire their services. This method of distribution has, however, nearly reached its limit for the time being and the Estate will now have to consider how it can, to most advantage, dispose of the annual outturn of young bulls direct to the raiyats.

2. About 1905, the Board of Revenue, then in charge of the Hathwa Raj Court of Wards Estate, organized the Siripur experimental and cattle breeding farm. At first some haphazard experiments in cross-breeding were arranged in both Australian Ayrshire cattle and Montgomeries but the policy finally adopted was to select cattle of the true country type on the lines laid down for the Pusa herd and to breed bulls of a stamp calculated to improve the draught cattle of the district and specially of the tenants of the Hathwa Raj. The cattle were procured from the Shahabad and Saran *diaras* and from similar areas in the neighbouring districts of Balia and Ghazipur and the breeding operations attained a remarkable measure of success under the supervision of Mr. M. M. Mackenzie. In 1908-09 there were 113 animals in the herd including young stock. By 1910-11 the herd increased to 147 and from 1908-09 to 1911-12 thirty-seven well-bred bulls had been distributed on the Hathwa Estate. Unfortunately in 1911 the management of the Estate passed out of the hands of the Court of Wards and breeding operations were stopped just at the period when the herd was reaching its full development and the effect of the fine animals in the Hathwa Estate was beginning to be seen.

3. Besides countenancing and supporting the cattle-breeding establishments at Pusa (subsequently Bettiah) and Siripur, over which they did not hold the ultimate control, the Government of Bengal confined their activities to a somewhat slightly pressed admonition to District Boards and other local bodies to maintain bulls of a good type for the improvement of cattle. No distinct policy was however laid down for the Boards to follow and no sustained endeavour was made to assist local bodies in procuring animals suitable either for the breeding of draught bullocks or for the production of dairy produce. The results were accordingly very meagre and at the end of 1912-13 there were only 7 stud bulls belonging to the District Board in five districts. From the above, it will appear that very little had been done by the Government of Bengal towards the improvement of the breed of cattle and a general survey of the cattle of the provinces in the end of 1912 disclosed that the deterioration of breeding sires had already in places progressed very far and the fear of the consequent degeneration of the young stock was well founded and that the old indigenous system of releasing Brahmini bulls was no longer sufficient for the needs of the country and was indeed breaking down under the strain of modern conditions and with the advance of cultivation. These facts were brought by the special officers who made the survey to the notice of Government and they decided that liberal expenditure on the organization of a cattle-breeding farm was justified.

4. In the end of 1913 some 250 acres were acquired by Government for the purpose of a combined sugarcane and cattle-breeding farm at Sepaya in the Saran district not far from the Siripur Station. The area of the farm was however soon seen to be too small for the combined farm and it has been resolved to devote the land obtained at Sepaya to cattle-breeding alone. The services of Mr. M. M. Mackenzie were obtained and the farm placed under his charge. By the generosity of the Maharani of Hathwa a stud bull and a number of the best of the cows and female stock of the derelict Siripur breeding farm were presented to Government. They formed an admirable nucleus for the breeding herd and subsequent purchases will be made on the same principles as before in Shahabad, Saran, Ballia and Ghazipur and will correspond generally with the present stock. The breeding herd at present in the farm consists of 4 bulls of breeding age, 50 cows, 14 heifers and 51 calves. No purchases of breeding stock have yet been made, but it is proposed that the breeding stock should consist of a herd of 100 cows and a dairy herd of 50 more cows specially selected. The intention is to breed primarily for draught purposes but to combine with this the endeavour to produce a dual purpose animal suitable for both draught and milk. The breeding herd should permit of the distribution of 50 bulls annually to District Boards, Government and Wards Estates and above all to Co-operative Societies. Three bulls have already been supplied to the Gaya District Board for the use of the Co-operative Societies and one to the Purnea District Board. As regards the female cattle, the milking capacity of each cow will be carefully tested, the dairy herd proper will be milked dry according to European practice and the calves will be reared by hand to ensure the accuracy of the milk records which will be attentively scanned with the object of casting from the herd the poorest milkers and retaining only the best so long as they are satisfactory in make and shape and suitable as the dams of first class draught animals. A certain amount of attention will also be paid to the improvement of the local milch buffalo by the importation of a limited number of bulls and cows of the celebrated Rohtak, Delhi and Hissar milking strains.

5. The Sepaya farm is intended to further the improvement and prevent the degeneration of cattle in Bihar North and South. The other two tracts, *viz.*, Chota Nagpur and Orissa, differ from Bihar in almost all particulars and the type of bull that is being bred at Sepaya cannot be usefully introduced into Chota Nagpur or into Orissa in the present agricultural conditions obtaining in these areas which are unfavourable to cattle-breeding. It will probably therefore be necessary in my opinion to create two more cattle-breeding stations to meet the needs of the Chota Nagpur and similar hilly districts and the coast districts of Orissa. It is possible however that one more cattle-breeding station situated in a favourable position, say, in the Ranchi or Singhbhum district might be found sufficient to meet the needs of the whole of the centre and south of the Province. A Deputy Director of Agriculture has recently been posted at an agricultural station near Ranchi and it is intended that he shall make enquiries in the Ranchi district, in Palamau and possibly in the Native States of Jashpur and Sarguja, which border Palamau on the west and where cattle of a better type than are available in British territory are supposed to exist in the jungle and where grazing facilities are more ample. Proposals will shortly be submitted to Government that the Deputy Director of Agriculture should purchase a bull of the best type of hill cattle and five or six good young breeding cows and should for the present maintain this stock on the new agricultural station near Ranchi. These proposed measures however are merely by way of experiment and if anything useful is to be done for the cattle of the hill country a much larger scheme will have to be evolved at no distant date.

I have shown above what has been done and what should be done by way of establishment of cattle-breeding stations which was recommended as a point of particular importance by the Committee appointed to consider the subject of cattle-breeding at the meeting of the Board of Agriculture in India held at Coimbatore in December 1913. The recommendations of the Committee on this point were as under :—

(1) Increase in number of cattle-breeding stations to be located in breeding districts where there is likely to be a demand for bulls ;

(2) maintenance of indigenous breeds of value by devoting separate farms to maintaining the purity of these breeds ; and

(3) certain definite tracts should be recognized as breeding tracts and effort at first concentrated in these tracts.

These points were, as has been noted in the previous paragraphs, kept in view in the creation of the farm at Sepaya and will likewise guide our future activities in this direction. The breeding tracts in Bihar are (1) Purnea or the Kosi *diaras*, (2) the Bachhaur Pargana in the Madhubani Sub-Division of the Darbhanga district, (3) the Sitamarhi Sub-Division of the Muzaffarpore district ; and (4) the Shahabad and Saran *diaras*. It is in the last of these tracts that the Sepaya farm is situated. It is at a distance of only 18 miles from Siripur and is situated in a country of the same nature. The cattle-breeding operations at Siripur were attended with the greatest success, and the conditions being practically indentical, similar success may be anticipated at Sepaya. The cattle that formed the nucleus of the breeding herd were of the true country type and had been obtained for the Siripur farm from the Shahabad and Saran *diaras* and in similar areas in the neighbouring districts of Ballia and Gazipur. Maintenance of the indigenous breeds will be the object of the breeding operations at Sepaya.

Other points recommended by the Board of Agriculture as of importance with reference to cattle breeding are—

(1) Preservation of grazing grounds in forest areas.

(2) Improvement of waste areas.

(3) Distribution of stock from the Government Farms.

(4) Cattle shows.

(5) Elimination of undesirable male stock.

(6) Increase of staff.

(1) and (2). It is recommended that the grazing lands of considerable extent should be acquired if there is any danger of their being utilized for other purposes and should be devoted solely to pasturage and that the improvement of waste areas should be systematically undertaken with a view to increasing grazing and fodder facilities. Not only would the expense of any such scheme be entirely be prohibitive but it can not be shown that the advantage to be gained would be in any way proportionate to the expense. In Bihar stall-feeding is fully established. The practice is fully in vogue in congested areas. In the neighbourhood of large towns it is now the custom to grow heavy crops of maize and *juar* especially for cattle food and there is little doubt that this practice will spread gradually to the remoter villages as the value of cattle rises. In Bihar, therefore, the line of progress lies along the road of cultivation of fodder crops by improved methods, the introduction of better implements to permit of deep cultiva-

tion, where such is proved to be advantageous and the use of chemical manures to produce the maximum possible of fodder off a given area. In Orissa and Chota Nagpur, agricultural conditions are unfavourable to cattle-breeding. Grazing is unsatisfactory both in quality and in quantity and stall-feeding is poor. In these divisions the question of fodder must be solved or must be on the way to solution before any real advance can be made by the introduction of a better strain or an improved breed. Something may perhaps be done through ensilage but the first difficulty is to persuade the cultivator to grow fodder specially for cattle food.

(3) *Distribution of stock from the Government Farms* :—

The question of the best method of distribution is a thorny one and will require much careful study, it can only be satisfactorily solved by a thorough knowledge of local conditions and with the hearty co-operation of District Officers. The maintenance of bulls by District Boards which the Committee condemned has in Bihar been productive of the minimum of benefit at the maximum of expense. What is now wanted is that selected District Boards shall budget annually for the purchase of a number of animals from the Government farm and shall make arrangements for their concentration in given areas in the mofassil, and not in towns, in the charge of responsible persons. A scheme was considered last year by which District Boards shall purchase bulls from the Government Farm and make them over to Co-operative Credit Societies on condition that they be responsible for their proper care and upkeep. In pursuance of that scheme a beginning has been made in a small way by distributing farm bulls to Co-operative Societies. Some simple rules for the management of the bulls are under preparation. The Co-operative Credit movement is, however, only in its infancy in Bihar and Orissa and is likely to take some years to reach substantial development. By that time the Government Farm will be in a position to meet the demands of the Societies for breeding bulls.

(4) *Cattle shows.* They have, as pointed out by the Committee, proved to be of very doubtful utility. This can hardly be otherwise so long as breeding remains the haphazard affair that is at present and so long as prizes are given not for breeding and bone so much as for fatness of condition. It may be possible to do something to raise a spirit of emulation when a considerable number of breeding bulls have been distributed to neighbouring Co-operative Societies and it is possible to give prizes for calves bred from certain Government-bred bulls. The donor of really good bulls might also be recognized and rewarded by Government in the same way as the builder of a *Sarai* or a roadside well.

The Committee recommended that in order to get rid of Brahmini bulls which in certain parts of this country form a great impediment to any improvement in the breed of the local cattle, pious Hindus should be encouraged to maintain *Goshalas* where these animals could be kept and that villagers should be encouraged to castrate the male stock before 18 months of age. That the deterioration of Brahmini bulls has actually taken place there is no doubt whatever, but in some areas Brahminis of excellent stamp are still available. A survey is required for which competent subordinate officers of the Veterinary Department, for example, officers of the grade of Inspectors or Deputy Superintendents, when such are available, should be deputed. The object of this survey would be to mark on a map by means of different colours the areas in which (1) Brahmini are good and plentiful, (2) such areas in which they are inferior and (3) areas in which they are bad. An organized endeavour should at the same time be made through the agricultural exhibitions and cattle shows and by means of lectures at such shows and through Co-operative Societies to create a public opinion which should be strongly adverse to the dedication of the inferior Brahminis as sacred bulls. Hindu gentlemen who desire to maintain the religious customs of releasing Brahmini bulls should be invited to obtain an animal of the best type suitable for his neighbourhood from the Government cattle-breeding institution. In distributing bulls to Co-operative Credit Societies, certain restrictions will naturally be insisted on such as the castration of all immature stock in the village, the deportation to a *goshala* of inferior Brahminis working in the neighbourhood and so on and the reasons for these restrictions should be explained at length.

In Bihar it is the practice to castrate early, usually at the age of 12 to 18 months so that the cows of a herd are not covered by immature bulls. In Orissa and Chota Nagpur castration is usually effected at the age of 3 to 4 years by mulling or breaking up the spermatic cord—a process which is very often incompletely carried out, the animals remaining only half emasculated. To remedy this evil a scheme is on foot with the object of reducing the number of young bulls in village herds in the encumbered estates in the Ranchi district to no more than two or three. Owing to the ravages of Rinderpest and Hæmorrhagic Septicæmia it is almost impossible to insist on the castration of all save one bull in village herd. The scheme by no means represents the ideal that should ultimately be aimed at but it is as great an advance as it is safe to make until such time as epidemic cattle disease is got under control.

Increase of staff. A general scheme of reorganization of the Veterinary Department is under the consideration of Government. In this scheme is included a proposal to recruit two more European Veterinary Surgeons for the control of the Chota Nagpur and Orissa sections of the province. When these officers have been recruited, trained and placed in charge of their circles a great step in advance will undoubtedly have been made but the ultimate object should certainly be to maintain a European Veterinary Surgeon in direct charge of each division of the Province

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(b)

Fodder Supply.

(D. QUINLAN, M.R.C.V.S., *Superintendent, Civil Veterinary Department.*)

The province of Bihar and Orissa covers an area of about 100,000 square miles, and stretches from the borders of Nepal to the Madras Presidency. On the west it is bounded by the United Provinces, Central Provinces and some Native States, while on the east, it is bounded by Bengal, three districts of the Orissa Division, Balasore, Cuttack and Puri having a frontage on the sea. The distance from the north to south is about 600 miles and from east to west about 200 miles at the widest part.

Climate. The climate on the whole shows no such great variations as are to be found in the northern parts of India, this being attributable to its proximity to the sea. The temperature in the districts adjacent to Nepal, and in Chota Nagpur may, however, approach freezing point in the cold weather, and in the hot weather a temperature of 112 degrees to 115 degrees not infrequently occurs for a month or so. In Orissa, on the other hand, except in the districts bordering on the Central Provinces, there is less variation between the cold and hot weathers.

The geographical position of Bihar situated as it is at the head of the Bay of Bengal and athwart the track of the monsoon current, ensures for it a very large share of the annual rainfall, the result being that it very seldom suffers from scarcity of water, or from the famines which are almost a yearly occurrence in the western and northern provinces and which cause such serious loss to the cultivators and to the country in general.

The average rainfall is between 50 and 60 inches and is very evenly distributed. It is heaviest, however, in Purnea district which is close to the Himalayas and in the coast districts of Orissa. Certain tracts, notably the Chota Nagpur plateau and parts of Sambalpur district, are liable to annual shortages of water owing to the conformation of the country, which is mainly low hills and valleys ending in steep ravines allowing it to flow away too rapidly unless "bunds" are made across the slopes of the country. These, however, do not always retain sufficient water to last from the end of one rain to the beginning of the next. In Bihar proper there is usually an abundant supply owing to the numerous rivers which intersect it in all directions. Orissa is also usually well supplied with this essential to life.

Physical features. For purposes of this report, the province may be divided into two areas: (1) the cultivated or plains area, (2) the uncultivated or jungle area.

(1) The cultivated or plains area comprises :—

(a) The flat alluvial plain lying between the Nepal frontier on the north and the range of low hills forming the northern boundary of the Chota Nagpur plateau and the Santhal Parganas on the south, in other words, it comprises the whole of the Tirhut, Patna and Bhagalpur Divisions except the Santhal Parganas and some small areas in north Champaran, south Gaya and south Shahabad, which will be dealt with later under (2). It is extremely well served by rivers and is divided into two fairly equal areas by the Ganges.

(b) The central portion of the Ranchi district plains, portion of the Manbhum District and small areas in Palamau and Hazaribagh districts.

(c) The plains areas of Balasore, Cuttack and Puri Districts, the Central part of Sambalpur and a small area in Angul.

(2) The uncultivated or jungle area comprises :—

The small tracts previously referred to in the north of Champaran and in the south of the Shahabad and Gaya districts, the greater part of the Santhal Parganas and extensive tracts in all districts of the Chota Nagpur and Orissa divisions. Under this head, may also be included such areas which though scattered through the cultivated tract cannot be utilized for growing crops owing to the character of the soil or because they are subject to floods or other visitations of nature. Good examples of those are the *diaras* on the Ganges, Gogra, Ganduk, Sikrana, Kosi, Sone, Brahmini, Mahanadi and other rivers.

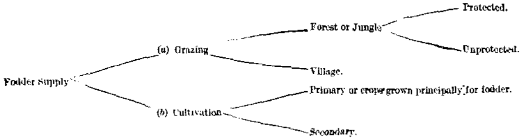
Cattle Breeding Areas. Before dealing with the question of fodder supply, it is necessary to point out the parts of the country in which cattle breeding is most actively pursued as a knowledge of these is essential for a proper appreciation of the difficulties which lie in front of those who wish to undertake the betterment of the cattle population which is after all the aim of the promoters of the fodder supply question.

Cattle breeding is most flourishing in districts which have abundance of grazing and food generally; or, when the district, though it has no large stretches of pasture, is yet able to send its herds to forests or jungles for grazing during periods of the year when there would be an undoubted shortage were they allowed to remain. It may be asserted that districts which grow good *rabi* crops, are also areas in which superior animals will be found for the reason that young cattle which have been selected by the owners as suitable for rearing will receive a constant supply of good food, either from the crops or from grazing. These are the conditions which prevail in Bihar and one of the reasons why the cattle—not ordinary village cattle—are so good as compared with those in other parts of the province.

The districts in which most cattle are bred and reared are Champaran, the northern parts of the districts of Muzaffarpur, Darbhanga and Bhagalpur, the whole of Purnea and the Santhal Parganas; in the Patna Division, the Ganges *diaras*, and the areas near the jungles on the south of Shahabad, and in Orissa in jungle tracts of each district, and in the Tributary States.

It appears to be advisable that some distinction should be made, in addition, between the different classes of cattle for purposes of this report, so I divide them according as they are (1) of direct economic value under which head would come work bullocks, cows of breeding age and selected young animals and (2) useless and a burden on resources; under this category would be found all old and worn out bullocks and cows and animals which have been rendered worthless through disease or other causes. This latter section forms a fairly large proportion of the cattle population. This means, in turn, that a considerable portion of the fodder supply is used up, in maintaining what one might call a most unproductive section of it.

Fodder supply. The sources from which the supply of food for the maintenance of the cattle of this province is obtained can best be shewn in the tabulated form herein set forth.



Village grazing. Grazing may be divided into two heads: (I) Village grazing and (II) Forest or jungle grazing.

Ordinarily speaking, it may be said that grazing especially in the villages in the large areas which are under cultivation, *e.g.*, in the cultivated plains areas (a), (b), (c) as a means of supporting life and at the same time supplying an excess of food material which can be converted into the energy which is required for the improvement of the breed to which the animal belongs, may be said not to exist in this province. Cattle, as a rule, which have to depend on their food supply from this source without abundant stall feeding are small, weedy and usually worthless for heavy work of any kind. Cattle in Chota Nagpur and Orissa exemplify this statement. The main object therefore of most village grazing grounds is to act as an exercising area for the work cattle and as a place where old and otherwise useless animals may eke out what living they can, until they die either from disease or naturally.

The above remarks do not apply to villages situated on the *diaras* and in Purnea and north Bhagalpur where the grazing is excellent, and capable of supporting many more cattle than it does.

Forest or jungle grazing. As pointed out in a previous paragraph, most of the cattle breeding which is carried on in this province is done in the districts which are adjacent to areas which are capable of supporting a large number of cattle during the periods of the year when food is scarce and grazing is bad in the villages from which they have been sent. The persons employed in this occupation recognize the advantages of having such good grazing areas for their animals, especially for the young stock and the cows, as the period during which the latter continue to give milk is lengthened, while the amount of milk is also increased and thereby benefits the calves immensely.

Grazing in jungles may be divided into (I) that which is obtainable in forests protected by Government and II) that which is to be had in open or ordinary unprotected jungles.

Taking the latter first, it may be said that great waste takes place owing to the absence of restrictions which would close overgrazed blocks of jungle for certain periods, prevent old and worthless animals from taking the fodder which rightly belongs to cattle which are of economic value, and, also reduce the number which are admitted for grazing.

In the protected areas, on the other hand, the number of cattle which are permitted to graze in each forest block is laid down by the Forest Officer in charge of the particular circle and a fee is charged. There is thus no tendency to over-crowding and people send to these areas only the cattle which they are assured will repay them for the expenses incurred in keeping them there.

All the protected forests under Government are practically confined to the Chota Nagpur and Orissa Divisions. A large area of unprotected forest is also to be found in the same divisions and it appears to me from what I have seen of those divisions that immense benefit would be conferred on the villages adjacent to those jungles if Government were to take them over from the Zemindars and villagers and place them under the Forest Department.

As regards the fodder plants in the jungle itself, they consist mostly of coarse grasses and the leaves of trees, bamboo shoots, etc. In the *diaras* of the large rivers and in the north Bhagalpur excellent grazing is obtained over the country from which the floods have receded.

Food supply in cultivated areas. I have previously pointed out that village grazing in the cultivated areas may be left out of consideration except in the villages which are situated close to the large rivers. The sources of fodder supply in these parts may, therefore, be divided into—

(1) Crops which are primarily sown for fodder;

(2) Crops which are grown for grain, but the stalks of which are always used as food.

(1) It may be taken as a general rule that no crops are grown specially for the purpose of feeding cattle, except in the indigo factories and among rich natives or on Government Farms. An exception, however, must be made to this statement in the case of low lying lands which are subject to flood, more particularly in Purnea and north Bhagalpur. In these *jheels*, *khesari* is sown broadcast and after the water has receded a rich crop of good fodder is available for the herds of cattle and buffaloes which graze in those tracts in such large numbers.

(2) The principal crops which are used for feeding purposes under this head are rice, oats, wheat, barley, gram, peas, *makai*, sugarcane, pulses, millets and oil-seeds, the straw or grain or both of all of them being generally used as well. In the case of oil-seeds, the residue, after the oil is extracted, is pressed into cakes, and as required is mixed with other foods, such as straw of oats, wheat, barley, rice, etc., and is given to make them more palatable and nutritious.

Conservation of fodder. The above list is a comprehensive one, but even so, it will be found that the cultivator in Bihar uses every portion that contains any nutrition at all and that as regards economy in their use, he requires no instructions from anyone, although it is true he is ignorant of the methods by which fodder plants which are in abundance or going to waste during the rains, can be stored, until the dry weather, when green fodder is scarce, comes round again. All crops which can be grown under cultivation can be placed in a silo. In parts of the country where *makai* is largely grown, the use of the silo pit in my opinion is absolutely essential because the stalks if they are cut down and placed in the pits after the cobs are harvested, retain their green state and many of the hard and fibrous portions are converted into digestible and highly nutritious food.

In 1913, when I was touring in the Ranchi district at the end of the rains I was struck by the amount of fodder which was allowed to go to waste through the absence of some means of storing it. Quantities of grass which in the dry weather is innutritious and indigestible, would, if it had been cut and placed in silage pits, be of the greatest benefit to the cattle of the villages to which these jungles belong. These remarks apply to all areas in the Forest tracts, more especially Sambalpur, Angul, Cuttack, Khurda and Puri.

My experience of silage pits in Sripur and in other places in the province convince me that they are the only means by which we can help the ryots to put by a sufficient quantity of food in a suitable manner for their animals. I can put forward no other suggestion which is as practicable or so certain of success.

As regards the means by which this system of storing fodder could be introduced in villages, I do not think that there is any other way of doing it on a large scale than through the Co-operative Credit Societies. In all villages where the Co-operative Credit Societies movement has been a success either pucca silos or pits should be built and one at least, in each *thana* of the province, should be put up by Government for demonstration purposes. Although the suggestion previously forwarded by me does not appear to have received attention, I am still of opinion that Government should place at the disposal either of the Agricultural Department or Registrar of Co-operative Credit Societies large sums of money annually for such silos.

I have no other suggestions to make on fodder supply in this province and in submitting my remarks I should say that the reduction in the number of useless animals and the provision of silos are the two means by which any scarcity of food can be kept in hand.

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(4)

UNITED PROVINCES.

Letter No. 122-C.—V-930, from the Director of Land Records and Agriculture, United Provinces, Lucknow, to the Agricultural Adviser to the Government of India, Pusa.

With reference to your letter No. 1241-7, dated 14th September 1915, I have the honour to send herewith two notes on cattle-breeding. They will form part of the programme of the Superintendent, Civil Veterinary Department, United Provinces, which will shortly be sent to you with other programmes.

2. With regard to food and fodder supply, some progress has been made with the scheme for reclamation on a large scale of ravine areas undertaken by the Forest Department. Already grass in some quantities is being produced, and when a larger area as arranged, is taken up there will be a considerable increase in the output. Under the arrangements now being made with zamindars an additional area of some 25,000 acres will be brought under control. Judging from the experience of this year in which fodder was plentiful, one of the difficulties of management will be in securing a steady market for the grass, and it may be necessary to keep a considerable portion under grazing.

Circular letter No. 2077-2247, dated 14th July 1914, from the Superintendent, Civil Veterinary Department, United Provinces, to all District Officers, Talukdars and Zamindars of the United Provinces.

1. As the Government cattle farms have commenced the issue of bulls for breeding purposes, and it is hoped will issue them in larger numbers in future, it is considered desirable to publish some information regarding the different breeds of the bulls reared at the farms, the areas for which they are most suited, and the general management and care of the animals, also to give some directions regarding breeding operations generally. This is the more desirable as there has been, in some instances, misunderstanding regarding the purpose of the farms and the character and utility of the animals issued from them.

2. It must, in the first place, be clearly recognized that as far as cattle are concerned the conditions in every part of the United Provinces are not alike and, whereas in some places one breed or class may be eminently suitable, the same animals would be of comparatively little value in others. The most distinctive breeds of cattle in these Provinces are those associated with the breeding grounds in the submontane districts. The best known of these are the Kherigarh, Parehar, and Ponwar (Pilibhit). [For fuller description of these the monograph on indigenous breeds of cattle in the United Provinces by Mr. Oliver, Superintendent, Civil Veterinary Department, should be referred to.] They are small active animals of great endurance, and are mainly used for quick draft and for the rice fields of the submontane districts—being largely exported to the rice-growing lands of Bengal. In direct contrast with these are the large heavy type generally known as "Kosi" which are in use in the Western districts. Here the fields are larger, the character of the soil and cultivation are different, and a larger type of animal is required. Intermediate between these two come the miscellaneous type of animal, generally somewhat larger than the Kheri-

garh and smaller than the Kosi, and found over the greater part of the provinces. [In Bundelkhund, the conditions of which rather resemble those of Central India, there is an indigenous type of animal known as the Kunwaria which should be developed in preference to the breeds from other parts of the provinces.] Generally speaking the small cattle of North Oudh are much valued in the mainly rice-growing tracts, while outside these there is a greater demand for the larger breed of bull of the Kosi or Hissar type. There is a further reason for this in the fact that the former class of animals are entirely unsuited for dairy purposes, the cows being extremely poor milkers. When, therefore, application is made to the Government farms for bulls, regard must be had to the character of the animals in use in the district or part of the district where the bulls are to be located, and to the purpose to be served. It must be clearly understood, therefore, that animals of the following breeds, viz., the Kherigarh, Parehar and Ponwar are not dairy cattle, and the bulls should on no account be purchased by municipalities or co-operative dairies, if the object is to breed milch cattle.

3. There are now two Government cattle farms in the provinces—one at Manjhra in the Kheri district, and the other at Madhurikund in the Muttra district. The former district has long been famous for its breeds of cattle, mainly Kherigarh and Parehar. They are bred in large numbers not so much for local requirements as for export. They are annually purchased by dealers and taken away in hundreds towards the eastern districts and Bengal.

As the result of a cattle survey a few years ago it was ascertained that many of these breeding herds were seriously diminishing: one of the chief causes being the want of good bulls. The Kheri farm was accordingly established to maintain an adequate supply. The farm is now in full working order and is capable of turning out a considerable number per annum. The difficulty, however, is to reach the actual breeders, and on this the prospect of ultimate improvement must depend. The owners are for the most part small men who are unwilling or unable to pay the price fixed for the bulls from the Government farms. The District Boards, Taluqdars, Courts of Wards and others could give valuable assistance by supplying bulls from the Government farms to the breeding tracts or paying part of the cost. The Boards principally concerned are those of Pilibhit, Kheri, Bahraich, Gonda, and Gorakhpur.

The farm at Madhurikund will deal with another class of animal. There has arisen a strong demand in many parts of the provinces for a moderately large-sized working bullock and a better milk-giving cow. Unfortunately with the exception of the Mewati or Kosi strains there are no special breeds of cattle which can be considered indigenous to these provinces combining both these qualities. It is, however, hoped that by crossing the ordinary *desi* cow of good stamp with the Hissar breed of bull some improvement, both in the frame and milking capacity of the animal might be effected. The introduction then of bulls of this breed seems to be indicated, but the difficulty which has hitherto been met with is that it was found practically impossible to obtain these animals. It has, therefore, become necessary to breed them and the Department has now started a farm for this purpose from which it is hoped, in a few years, a considerable number of bulls of the Hissar and other good milk-producing strains, as well as stud buffaloes will be forthcoming. Good cattle, however, cannot be bred at a moment's notice and some little time must necessarily transpire before they can be ready in any quantity.

In the meantime, however, the Superintendent of the Civil Veterinary Department would be glad to hear from those who are likely to require the animals as to what their probable requirements will be, and what arrangements they propose to make for their location and working, as well as the local control and supervision of their breeding operations.

4. The following suggestions are offered with regard to supervision and management of bulls :—

With regard to the methods of utilizing the services of these two distinct classes of bulls, *viz.*, the submontane and western breeds, it is essential to clearly realize that they are entirely different in their nature and habits and each requires a different line of treatment.

Class (1), *viz.*, those bred at the Kheri farm are of a semi-wild disposition, and cannot be managed in the same way as the more domesticated breeds. It has been found that the best way to deal with them is to allow them to roam with the herds of cows of the selected groups of villages they are issued to. Any system of restraint, confinement, or treatment different to that met with in their natural state, makes them vicious and bad coverers.

In dealing with the other class (2) of cattle different treatment may be accorded them, and here the most satisfactory way of using the bulls seems to be to locate them in such places as the cows are most suitable and their services most required.

Local arrangements should be made to place the animal in charge of, and under the supervision of, some responsible person preferably of the zamindar class and a man who understands animals, rather than under a person simply because he is a Government official whose knowledge of cattle is often limited. There should be a herdsman or attendant of the *ahir* or *gwala* class.

A stable or house with a roomy compound should be provided and there should be some place in the close vicinity where the animal should be able to graze for a short time daily. The stable should be not less than 16 by 16 ft. and the compound at least 150 by 100 ft., and with a wall sufficiently high to maintain privacy and to guard against the animal being teased by children and others (a standard plan can be obtained by application to the Superintendent, Civil Veterinary Department). There should be a strong solid gate and arrangements for pure drinking water should be provided.

The food will to a great extent depend upon the size of the animal and local conditions—but for general guidance the following ration might be recommended :—

Crushed gram	2 seers.
Linseed oil cake or mustard cake	1 seer.
Bran	1 „
Bhusa	10—15 seers.

In addition to this a certain amount of suitable grazing, if procurable, should be given, and where possible a little green fodder such as *juar*, lucerne, barley, *methi*, if in season, may be allowed. A large block of salt should be placed in such a position that the animal may freely lick it, and a supply of water should always be at the bull's disposal.

As it is evident that the yearly number of coverings from one bull must be limited, it is important that only the most suitable cows, and those likely to produce good offspring, should be allowed to the animal. Diseased, undersized, malformed, weakly, decrepit, and barren cows should be rejected without hesitation, and preference given to the best specimens brought to the bull. The selection and passing of these animals will best be entrusted in the hands of a local committee. The number of coverings should be limited to 70 during the season, from January until July, when if completed he should not be allowed to cover any more for at least two months.

5. The question of the charging of fees can best be decided locally to suit the conditions of the neighbourhood. Where, however, it is decided that a charge should be made, a fee of from Re. 1 to Rs. 2 is considered suitable.

6. An accurate system of registration should be maintained, the register giving the descriptive marks, name of breed, and owner of the cow, and date on which she was covered.

7. As to the best methods of encouraging the breeding of an improved class of animals, cattle shows on the whole have not proved successful in these provinces, and very little progress can be traced to them. Where, however, annual exhibitions are held by Co-operative Societies or Agricultural Associations which attract considerable local interest, prizes might usefully be given to members of these societies or associations who exhibit the progeny of the bulls maintained. Generally speaking, however, it is preferable not to trust to the animals being brought to the district exhibitions, and it would seem better to inform cow-keepers that the young stock might be brought to some centre on a fixed date where they could be examined, and prizes awarded to the most promising. The Civil Veterinary Department is prepared to assist in awarding prizes.

In order to avoid inbreeding a bull should not be located in the same place for more than three years.

Every encouragement should be given to the castration of undesirable male stock in and about the neighbourhood where Government bulls are located. Undesirable and old bulls should be sent to a *gowshala*, or otherwise got rid of.

(E. W. OLIVER, M.R.C.V.S., F.Z.S., *Superintendent, Civil Veterinary Department, United Provinces.*)

In every part of India the improvement of cattle is a question in which the public interest is steadily increasing, and nowhere is this more evident than in the United Provinces. The price of working cattle and animals for dairy purposes has of late years been rapidly rising, as has the price of most other commodities. Although improved methods of agriculture are being introduced the extension of cultivated areas increases, with the result that the agricultural bullock is still more in demand than ever it was. At the same time the more enlightened cultivator is beginning to realise that more work and necessarily more profit, can be obtained from a strong sound animal of good breed than from a bad weakly one. Milk again once looked upon as a luxury amongst certain classes, is now becoming recognized as a necessity for the rearing of strong healthy children and for domestic consumption. Hence a much greater demand for this commodity has sprung up during the last few years and which will no doubt continue to increase. It therefore becomes evident that the points to be aimed at in attempting the improvement of cattle in those places where they are of inferior quality are—

(*a*) to produce bullocks capable of accomplishing a greater and more satisfactory amount of work, than those being now bred ;

(*b*) to breed cows which will give an increased and reasonable supply of milk.

Outside a few recognized breeding areas the absence of any fixed type of cattle is very noticeable, although in those particular areas which I shall mention some very excellent strains exist. Our aim should therefore be to continue to foster and maintain these fixed breeds in those tracts to which they are indigenous, but at the same time in the other localities where no such breeds exist we should endeavour to introduce improved outside strains of blood with the object of gradually fixing an improved type of cattle by a careful process of selection and grading up. Unfortunately at present cattle breeding is a science which few people have cared to interest themselves in. The smaller cultivator is often an illiterate, apathetic and somewhat prejudiced person. He has little money and still less time and inclination to devote his attention to questions of this kind. On the other hand, we have the large landowners and taluqdars who, although their intentions may be good, often do not show the practical personal interest in the matter which they ought. As the result of many conferences and discussions on the subject of cattle-breeding, it has unfortunately come to be thought that it is only sufficient to introduce into a herd of non-descript cows, bulls of some superior breed (either for dairy or draught purposes), and immediate improvement must take place. Now although we know that the introduction of superior blood is the first step in the improvement of a breed, it must not be thought that this is all that is necessary. It has taken years and sometimes centuries to build up the best breeds of animals even in the most clever and persevering hands. The care in the selection of cows, the weeding out of undesirable and worthless stock, the proper nourishment of both the parents and the young stock play an equally important role in the production of a good breed, but I am sorry to say these points are too seldom taken into consideration in this country.

Speaking firstly of draught bullocks, *viz.*, those required for ploughing and other agricultural operations, and for working wells, as well as those for use in *raths* and *bahlis* it should be distinctly understood that the same class of beast is not always suitable for each and every locality. This difference depends a great deal on the type of land, the depth of the wells and the customs of the people, etc. Thus we find in the western districts a very tall, massive, but slow type of bullock is generally used, whereas in North Oudh and the rice-growing tracts of Bengal the smaller, lighter, and more active breeds are the only suitable cattle for working purposes ; so, for general purposes of the people it would be as absurd to try and breed cattle of the huge Hissar type in the Kheri or Pilibhit districts as it would be to expect the people on the Muttra and Delhi side to use or breed the small class of animals I have mentioned. There are however in these provinces certain districts where cattle, medium in size, are required, and here great discretion should be used in the breeding operations.

Before starting on a breeding enterprise the question which should always first present itself should be, " What breed of cattle is required " then, " What size and class of bullock the particular tract is likely to support " ? and " What kind of animal for general purposes is mostly in demand " ? Having decided this the type of bull to be used can be decided on.

Even where improved breeding operations have already been started and Government bulls introduced, the hopes of the breeders are often rudely shattered by the harm which occurs by not taking the precaution of removing the evil influences of the inferior *brahmani* bull, the undersized immature or the old decrepit or other undesirable males, that are so often allowed to wander at large. Many good cows become covered by these animals, and on producing an inferior useless calf the blame is generally laid on the Government bull. I would then impress upon those contemplating the improvement of their cattle that unless steps are taken in this direction, by either castration or removal of the undesirable bulls in some way, their operations can only be doomed to failure. The breeding from immature, misshapen weakly or old cows should be equally avoided, as it is only a waste of time, money and forage.

Having then, we will suppose, selected the cow, and had it covered by the bull considered most suitable, this is not an end to the matter. It will be easily realized that during the period of gestation the cow has to not only support herself on the food she is provided with herself, but a rapidly developing calf within her. If this food is insufficient or of bad quality it will be obvious that the calf instead of turning out a sturdy and strong animal, will most probably be a weakly misshapen weed which will hardly pay for rearing. Hence the necessity for liberal feeding of a cow during her period of pregnancy. Having produced the calf, still more care is required until the animal is of such an age that it no longer requires its mother's milk. It is generally the custom in India to take nearly all of the mother's milk and leave very little for the rearing of the calf. This is done also in other countries but is compensated for by allowing the little animal some equivalent in the form of meal or some cereal food. When the calf is able to eat by itself suitable pasturage or other food should be provided for it. It cannot be expected that an underfed young animal can grow up to be a strong sturdy adult.

As regards the fixed breeds which should be maintained and fostered, or introduced to improve other less favoured stock, I would mention the following.

(*a*) *Kheri breeds.*—These are most suitable for Oudh and perhaps as far east as Benares and Gorakhpur. They are excellent workers and not fastidious in their food, but they give some trouble in breaking to work. They are relatively poor milkers. The Kherigarh, Parohar, and Manjhra Singhai strains are the best.

(*b*) *Pilibhit.*—The Panwar breed, found chiefly in Puranpur tahsil, is an excellent breed of small cattle, and is suitable for certain of large areas of Rohilkhand. The cattle are good workers, but are not distinguished as milkers.

(*c*) The Kenwaria strain is the most suitable for the greater part of Bundelkhand. These cattle too are good workers but relatively poor milkers.

(*d*) *Mewat* (Kosi).—This strain apparently is most suited to the Agra division. The cattle are of medium size, good workers and though not famous as milkers, give much more milk than most of the cows found in the province. They require usually more careful feeding than is possible in south Oudh.

It may be said that there is some difficulty in finding a breed that will give both more milk and better working stock than the existing cattle. When the breeding of dairying cattle alone is intended the introduction of bulls

from the Hissar or other good milking strains seems advisable, but for general purposes great care will have to be exercised. It would be unwise to indiscriminately introduce such an animal into the herds of already excellent breeds, which are of a different shape, size and character without due forethought, as the result would most likely be the production of an inferior if larger animal, with nothing to recommend it.

Of the cattle recommended as bulls ; where it is intended to breed dairy cattle and in certain tracts where the introduction of this blood has been proved to be successful the following breeds are recommended.

Hansi (Hariana).—These cattle are most suited to the districts of the Meerut division. They are large and costly animals, and require careful feeding ; they are good workers and also good milkers.

Montgomery.—This Punjab breed is now attracting much attention as an excellent milk-yielding strain : it is not anticipated that the bullocks bred in these provinces would be good workers, but the breed should be considered in cases where increased milk supply is the chief object.

For the guidance and information of local bodies, Co-operative Societies and private persons contemplating measures for the improvement of cattle, I would refer them to a circular on the subject recently drawn up by this department, and I would here mention that if any difficulties present themselves, the officers of this department are always ready to give them assistance and advice.

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(5)

PUNJAB.

Note on the progress made in 1914-15 in encouraging Cattle-breeding.

(C. A. H. Townsend, I.C.S., *Director of Agriculture and Industries, Punjab*).

1 The present strength of bulls is shown in the following table. It includes all bulls owned or approved by district boards, and also privately owned bulls to the cost of which district boards have contributed. There are of course also other private bulls in many districts, and many devoted bulls (*pun*) :—

Name of district	Number of bulls at present owned or approved by the district board (*i.e.*, on 31st March 1915) in the district	Number which district boards promised to buy in the scheme drawn up under circular No. 3 of 1911	1914-15, actually bought		1915-16, indents	
			From Hissar Cattle Farm	Elsewhere (as given in the annual note on cattle-breeding during 1914-15)	From Hissar Cattle Farm	Elsewhere (as proposed in the annual note on cattle-breeding during 1914-15)
1	2	3	4 (*a*)	4 (*b*)	5 (*a*)	5 (*b*)
Hissar	73	20	14	....	25	
Rohtak	12	5	2	....	6	
Gurgaon	33	4	5	....	7	
Karnal	36	10	9	....	10	
Ambala	33	4	9	....	10	
Kangra	13	..	..	6 Montgomery bulls	..	
Hoshiarpur	42	..	7	....	10	
Jullundur	44	4	24	....	15	
Ludhiana	29	6	6	....	6	
Ferozepore	70	10	12	4 Dhanni	6	
Lahore	42	20	15	1 charity bull, of Hissar-breed.	13	
Amritsar	55	11	22	....	4	
Gurdaspur	57	..	6	....	6	
Sialkot	22	5	7	....	9	
Gujranwala	39	4	8	....	15	
Gujrat	19	6	..	10 Dhanni	..	
Shahpur	13	4	..	4 Dhanni	8	
Jhelum	4	..	..	1 Dhanni	..	
Rawalpindi	4	..	..	3 Dhanni	..	
Attock	8	9	..	6 Dhanni	..	4 Dhanni.
Mianwali	21	..	..	4 Dhanni, 5 Dajal	..	
Montgomery	31	2	4	....	4	9 Montgomery bulls.
Lyallpur	36	..	12	....	12	
Jhang	3	..	..	....	5	
Multan	8	4	5	....	10	
Muzaffargarh	18	8	4	4 Dajal	6	2 Dajal.
Dera Ghazi Khan	..	..	..	....	..	
Total	765	130	171	48	187	

2. The figures in columns 4 (*a*) and 4 (*b*) of bulls actually supplied are an improvement of those of 1913-14, when 142 Hissar bulls and 19 Dhanni, Montgomery and Dajal bulls were supplied; but much more remains to be done in all districts, particularly Jullundur, Amritsar, Ludhiana and Gurgaon. Rohtak is improving, but is still extraordinarily backward for a very important cattle-breeding district. The alleged prejudice against Hissar bulls in this district which was noted in last year's report was specially enquired into and found to be, in the main, groundless. Shahpur, as was said last year, should have many more bulls in its colony, Montgomery should bear in mind the increased necessity of Hissar bulls as the Lower Bari Doab Colony comes under cultivation, and Jhelum and Rawalpindi should certainly have more Dhanni bulls.

Supply of bulls.

The Gujranwala District Board have under consideration a proposal of the Hafizabad Tahsil committee that each zaildar should buy one cow from the Hissar Farm at his own expense, and induce one zamindar in his zail to do the same. The male produce of these cows, mated with good bulls would, if approved by Civil Veterinary Department officers, be purchased by the district board at Rs. 100 each, and then let loose as bulls in the tahsil.

3. The policy of concentrating bulls around one centre, which was noticed in the note for 1912-13, and originated in the Lahore District, where bulls are concentrated around Kahna Kacha, is also practised only in Amritsar. No other district has yet seen fit to adopt it; indeed Gurdaspur and Gujranwala have declared themselves opposed to it.

Concentration *versus* distribution.

4. In the following districts individuals or villages have come forward to pay half the price of bulls from Hissar,

Contribution by villages for purchase of bulls.

1. Jullundur (Nakodar Tahsil)	18 (half price)
2. Ferozepore	16 „
3. Lahore (Chunian)	15 „
4. Gujranwala	4 „
5. Lyallpur	1 „
6. Gurgaon	1 (quarter price)

and animals were supplied accordingly. The Nakodar Tahsil figures are note-worthy. Gurgaon is making tentative efforts in the same direction, so is Gujranwala; principally because zamindars set no value on what they pay nothing for. The Hafizabad Tahsil committee wish to purchase 44 bulls for the tahsil, and will find half the cost if the district board find the balance. This is very encouraging. In Jhang also similar offers have been made, and will, I hope, result in definite purchases of bulls.

5. The practice of stall-feeding bulls and charging a fee for service does not seem to be increasing. In the year under report the following bulls were standing,

Stall-feeding and fees for service.

	Bulls	Cows served	Fee for service Rs. A. P.	Fees paid Rs. A. P.
Jullundur Tahsil	1	62	0 4 0	15 8 0
Rawalpindi	1	48	1 0 0	46 0 0
Gujar Khan	1	50	1 0 0	50 0 0
Bhakkar	1	40	0 4 0	10 0 0
Chiniot	1	101	0 8 0	50 8 0
Shorkot	1	25	1 0 0	20 8 0

in addition to which two more bulls have recently commenced to serve on this plan, in Rawalpindi.

In Jullundur, and probably in other places, the district board bull has to face the competition of the bulls belonging to the herdsmen near the city, who keep bulls, and charge very small fees for their use.

In nearly all other cases the bull is in charge of a zaildar, covers all cows without distinction, and is fed by the agricultural community it benefits as a whole. This system generally works well, but due care should be taken if the bull comes to grief, before punishing the zaildar or village in question. Such unpopularity as Hissar bulls have been said to incur in places in the past has in nearly every instance been traced to punishments inflicted in such cases: generally wrongly, and nearly always unwisely.

6. As was said last year registers of cows and bulls should certainly be kept up everywhere. Eventually a record of coverings by registered bulls and of produce should be maintained. In Jullundur it is reported that in the year under report 40 bulls sired 1,588 calves. In Karnal and Muzaffargarh also registers have been issued to zaildars for this purpose. It is hoped they will be maintained.

Registration of cows and bulls.

7. Nearly all the bulls, apart from the few Montgomery animals supplied in the year, were of Hissar breed, but 32 Dhanni bulls also were purchased and 9 of Dajal breed, all in the North and West Punjab. In the Gujrat District, Gujrat, Phalia and part of Kharian Tahsil prefer the Hissar breed. Shahpur, Sargodha and Bhera Tahsils appear to favour the Dhanni and Hissar breeds about equally. All the remaining circle in the North Punjab prefor Dhanni bulls.

Dhanni and Dajal bulls.

The stud farm of Ahmad Khan of Dhandla in Bhakkar is progressing well. The Superintendent, North Punjab, however noticed that, though there were some good animals amongst those kept, there was no complete arrangements for a stud of any particular breed. I hope the Deputy Commissioner will look into this point.

In Montgomery, Multan and Muzaffargarh there is reason to believe that breeding a good class of work bullock is claiming more attention from the people. In the first two districts very good work is being done by Hissar bulls. In parts, however, both of Multan and Muzaffargarh, there is a preference for good Dajal bulls as sires. Unfortunately the supply of really good specimens of this breed is limited. The report on Dhanni bulls by the Superintendent, Civil Veterinary Department, North Punjab, has been distributed.

8. The leases for cattle farms in the Montgomery District mentioned in paragraph 8 of last year's note are getting under way. Four large farms and one small one have been sanctioned. A farm somewhat on the same lines at Kaliana in the same district has been working for some years, though not very satisfactorily.

Cattle farms.

9. Public opinion is gradually bringing about an increase in the number of unsuitable bulls that are being removed, but progress is very slow. In Hoshiarpur, however, no private bull was issued without the approval of the cattle-breeding sub-committee; in Jullundur unsuitable bulls were castrated and sold, the money thus realized being subscribed towards the purchase of more Hissar bulls. In this connection I may note that the cattle-breeding committees are generally reported to be of little use, in a few districts however they seem to do useful work. A great deal depends on the Deputy Commissioner; if the sub-committee sees he is interested in cattle-breeding, it will do more than where the reverse is the case.

Removal of unsuitable bulls.

One hopeful sign is that castration by scientific methods is becoming daily more popular. Apart from the large number of castrations done in veterinary hospitals during the year, the number of bullocks castrated by Veterinary Assistants when on tour rose from 14,000 to 18,000.

10. At the close of the year there were 765 district board bulls at work in the province against 637 last year; 91 were cast as old and useless. The Hissar Farm supplied 171 Hissar bulls on indent, while 48 of other breeds were purchased by the Civil Veterinary Department for district boards.

General.

Generally an improvement in young stock is visible in many districts. And the zamindar is certainly waking to the fact that the steadily rising price of cattle will soon render it difficult for him to get his land cultivated at all unless he pays more attention to cattle-breeding

(6)

BOMBAY.

Report of the Committee appointed to consider measures for the improvement of the Milk supply in large Cities in the Bombay Presidency.

Introductory.

1. The economic side of the question was considered with particular reference to Ahmedabad, Surat, Poona, Sholapur and Hubli, which were taken as typical large cities of this Presidency. The matter was not considered in detail with regard to Bombay City since it was recognized that the conditions of Bombay were special, and it was understood that a separate Committee was considering the matter with reference to Bombay. Certain aspects of the Bombay milk trade, however, received attention.

The economic enquiry fell under the following main headings :—

(1) The supply of milk to large cities as regards—

(*a*) Quantity,

(*b*) Quality—

(*i*) cleanliness ;

(*ii*) purity (freedom from adulteration).

(2) The effective demand for milk on the part of the different classes, and the uses to which milk is put.

(3) The sources and agencies of the present milk supply.

(4) Methods to increase the supply and improve the quality of the milk.

The technical considerations fell under the following main headings :—

(1) Breeding }
(2) Feeding } Milch cattle
(3) Housing }
(4) Tending }

(5) Preserving milk by—

(*a*) sterilising,

(*b*) pasteurising,

(*c*) refrigerating,

(*d*) cooling.

(6) Transport of milk.

CHAPTER I.

THE EXISTING SUPPLY OF MILK AND THE MANNER OF ITS CONSUMPTION.

2. *Quantity.* As regards the quantity of milk available in large towns the following estimates have been made, based either on figures of animals in milk, collected on a particular day, or on special enquiries that were made for the purpose of this Committee.

Ahmedabad.—Population (inside the city walls) (172,000)—

Source.	Daily supply. lbs.	per cent.
From 1,548 buffaloes and 573 cows kept within the city	23,000	(55)
Brought into the city from outside	19,000	(45)
Total .	42,000	

Surat.—Population—114,000—

Source	Daily supply. lbs.	per cent.
From 1,000 buffaloes and 250 cows kept within the city	12,000	(28)
Brought into the city from outside	30,000	(72)
Total .	42,000	

Bombay City.—Population—979,000—

Source.	Daily supply. lbs.	per cent.
From 18,000 buffaloes and 3,000 cows kept within the city	220,000	(83)
Milk brought into the city from outside	45,000	(17)
Total .	265,000	

Poona.—Population—117,000—

Source.	Daily supply. lbs.	per cent.
From 1,398 buffaloes and 1,350 cows kept within the city .	20,000	(80)
Brought into the city from outside	5,000	(20)
Total .	25,000	

Sholapur.—Population—95,000—

Source.	Daily supply. lbs.	per cent.
From milk animals, almost entirely buffaloes, kept within or close to the city	13,000	(100)

Hubli.—Population—60,000—

Source.	Daily supply. lbs.	per cent.
From 800 buffaloes and 400 cows kept within the city.	9,000	(90)
Brought into the city from outside	1,000	(10)
Total	10,000	

Goat's milk has not been considered, though goats are to be found to a greater or less extent everywhere.

According to these estimates the available supply per head of population works out at—

	lb.
Ahmedabad	·24
*Surat	·36
Bombay	·27
Poona	·21
Sholapur	·13
Hubli	·16

Apart from the greater supply of milk available in Gujarat, this difference is noticeable between the conditions of milk supply in Gujarat and the Deccan that whereas in Gujarat over half the milk is brought into the city from outside villages, in the Deccan the great bulk of milk is produced within the city itself.

No attempt has been made to estimate the amount of butter, *ghee* or *mava* (dessicated milk) that is brought into towns, but it may be mentioned that a certain amount of butter-milk or of soured curd made from milk, from which the whole or part of the cream has usually been removed, is brought into most cities and consumed by the poorer classes of the population.

3. *Quality.* As regards the quality of milk there is a general complaint from all sides that the conditions under which a large part of it is produced and handled are insanitary, that much of it is dirty and most of it adulterated. It is a matter of common knowledge that the condition of most cattle-sheds is such that milk drawn in them is very liable to contamination, and that little or no care is taken to secure the cleanliness of the animal or of the milker before milking is commenced, or to protect the milk from contamination during transit or before sale. The work done in Bombay by Dr. L. L. Joshi indicates the presence in commercial milk of manurial and other contamination (*vide* paper read by Dr. Joshi at the All India Sanitary Conference, 1914, and the paper by Dr. Joshi in the "Journal of Dairying and Dairy Farming in India" for October 1915). The contamination of milk has been little studied in other cities.

As regards adulteration of milk in Poona, analyses made by Dr. Mann of samples purchased in the milk market gave the following results :—

(*i*) One sample bought at 4 seers per rupee was genuine.

(*ii*) Of three samples bought at 5 seers per rupee two had water added to the extent of 10 per cent of the original milk.

(*iii*) Of three samples bought at 6 and 7 seers per rupee all were adulterated to the extent of one-half of added water.

(*iv*) Of three samples bought at 8 and 9 seers per rupee all were adulterated to the extent of 135 parts of water for every 100 parts of original milk.

In the case of milk retailed in the Poona milk shops the extent of adulteration is even worse. These figures refer to milk brought into the city from outside villages. In Gujarat the milk trade of cities is in the hands of Ghanchis, or milk sellers, who advance money to villagers to secure their daily milk supply. These Ghanchis are said to make periodic tests of the milk brought them by villagers, and in this way secure the milk unadulterated to a very great extent ; but the public do not therefore get the benefit of pure milk. On the contrary, the Ghanchis systematically adulterate the whole milk either with separated milk or with water, and since they hold a practical monopoly of the sale of milk from outside, the only way to obtain pure milk is to come to special terms with a Ghanchi. In this way a regular customer, who is prepared to pay, can secure milk without risk of any further adulteration than may have been done by the producer.

In view of these deficiencies in cleanliness and purity it is everywhere recognized that the best way to obtain clean and pure milk is for a man to keep his own cow or buffalo, and this accounts for the large number of such animals kept in large cities for domestic milk supply. Failing that, the next best way is to make permanent arrangements with a gowli for a daily supply of milk and to see the milk drawn. In some towns it is the custom for gowlis to bring their buffaloes round to customers' houses, in others to definite milking stands, and in others again the customers go to the gowlis' sheds to personally superintend the milking and carry of the purchase. In such ways pure milk can be obtained by regular customers who are prepared to pay high and take trouble. It is the casual purchaser who buys milk in the market, shops or streets who is the chief sufferer.

4. *Price.* It is recognized everywhere that there are at the same time and place different prices for milk which in the main denote the extent of the adulteration ; but for approximately pure milk the retail prices may be taken roughly as follows :—

	lbs.
Ahmedabad	13 to 16 per rupee.
Surat	13 to 16 „
Bombay	7 „
Poona	8 „
Sholapur	10 „
Hubli	12 „

The tendency everywhere is for milk to be cheaper during the months of August to October when the supply of green grass makes it more plentiful ; but many regular purchasers arrange with gowlis to supply it at the same rate throughout the year, and many milk sellers affect to sell it even to casual customers at the same price throughout the year, increasing the adulteration as the milk supply decreases.

* *N.B.*—There is a considerable export of sweetmeats from Surat.

5. *Demand for milk at current prices.* Apart from the demand for domestic consumption which accounts for the great bulk of the supply there are other sources of demand which have been roughly estimated as follows :—

Ahmedabad—	lbs.
Tea shops	3,500 a day.
Sweetmeat makers	4,500 „
Curd makers	2,000 „
	10,000
	(24 per cent. of the whole supply).
Surat—	lbs.
Tea shops	1,000 a day.
Sweetmeat makers	8,000 „
Curd makers	2,000 „
	11,000 „
	(26 per cent of the whole supply).
Poona—	lbs.
Tea shops	4,000 a day.
Sweetmeat makers	1,000 „
Gymnasts	600 „
	5,600 „
	(22 per cent of the whole supply).
Sholapur	lbs.
Tea shops	300 a day.
Sweetmeat makers	1,000 „
	1,300 „
	(10 per cent of the whole supply).
Hubli—	lbs.
Tea shops	750 a day.
Sweetmeat makers	750 „
	1,500 „
	(15 per cent of the whole supply).

6. *Distribution of milk amongst the different classes and the use made of it.* In paragraph 2 (*a*) an estimate was given of the supply of milk per head of population in the different large cities. It must not be supposed, however, that this in any way represents the distribution of the milk amongst the various classes of the town populations. On the contrary, it is well known that at present prices a large portion of the population, estimated by Dr. Mann at 60 per cent., are unable to afford milk at all, except in very small quantities which they purchase for their children. The demand for milk amongst the various castes has been estimated at Poona to work out roughly as follows :—

Brahmans are the largest individual consumers, adults consuming about 1½ lb and children 1 lb. daily amongst the richer families, and about half this amount amongst the poorer.

Prabhus consume appreciably less.

Lingayats very little.

Marathas. Well-to-do families consume somewhat less than Brahmans. Poorer Marathas can afford none except for the children : and the same is the case with the great majority of the families of low caste.

Amongst Brahmans in the Deccan about 50 per cent, and amongst other castes a less proportion of the domestic supply is consumed in a soured and curdled state. The methods by which this is prepared vary amongst different classes and in different localities, but it is a common practice in the Deccan to extract a large part of the cream before the milk is used. The remainder of the domestic supply is used in tea or is drunk whole by adults and children. The cream which is removed in the process of making sour curd is made into *ghee*.

The poorer classes use practically no *ghee* at all.

7. *Infant feeding.* A consideration which in Western countries gives much importance to the subject of milk supply is the widespread practice of feeding infants by artificial means, a practice which has increased much in recent years ; and Major Hutchinson, Sanitary Commissioner, emphasized the great importance of breast-feeding to the health of children, as opposed to artificial feeding. The facts as regards this Presidency appear to be that breast-feeding of infants is almost universal, but in a fair number of cases, and in particular amongst the upper classes the supply of mothers' milk is deficient either in quantity or duration. In such cases breast-feeding is supplemented by artificial feeding. For this purpose cows' milk is preferred by the upper classes and goats' milk by the lower classes, but the poorer people have to be content with any kind of milk that they can get. When children are over six months of age rice *kanji* and soaked bread are fed to them. It is believed that in some localities artificial feeding of infants is becoming more common amongst the upper classes and even amongst the poorer classes when women work in mills or engage in work which keeps them away from their homes. We have not made detailed enquiries on this point, but Rao Saheb G. K. Kelkar expressed an opinion that in Poona 60 per cent of infants amongst the upper classes and 20 per cent amongst the lower classes receive artificial feeding to a greater or less extent.

8. *General considerations.* There is apparently a belief that the supply of milk in large towns is now-a-days less than was formerly the case. There is, so far as we are aware, no evidence that there has been any reduction in the actual quantity available, and we see no reason to believe that this is the case, but it is certain that the price of milk has largely increased of late years along with the price of other articles of food, and it is quite likely that the growth of population in large towns and the increase in tendency to tea drinking may have increased the demand for milk without proportionately increasing the supply and so may have accentuated the difficulty.

Contrasting the milk supply of large cities in this Presidency with cities in England the striking fact is that the price in each case is about the same though in India the price of food generally is much lower than in England and the spending capacity of the people much less. The reasons for this will be considered later on, but the result is that in Indian cities milk as an article of ordinary food is beyond the reach of the poorer classes.

CHAPTER II.

Source of supply.

9. *Milch animals.* Before considering the various agencies for the production and distribution of milk it will be desirable to consider the question of the animal best suited to the milk supply of towns. In villages goats are an economical source of milk, so far as the owner is concerned, and afford a useful supply of milk which is consumed mainly by children. They cannot, however, be kept on a large scale in cities, and do not lend themselves to milk

supply on a commercial basis; and we have, accordingly, excluded them from our consideration. The choice, therefore, remains between cows and buffaloes. It is found that of the milk supply of large cities the great bulk of the milk comes from buffaloes; and the reason for this is that for commercial production the buffalo is the most effective animal. So far as the Indian public are concerned they value the milk mainly for the fat contained in it, and consequently prefer buffaloes' milk which is much richer in fat; but apart from this they prefer the taste of buffaloes' milk, and it is only for children that they prefer cows' milk and require it to a limited extent. Gowlis depend almost entirely upon buffaloes, and though a few cows will frequently be found amongst their herds they are said to find them less economical as milk producers and to keep them only in order that they may meet, or affect to meet, the demand for cows' milk for children, or explain any deficiencies that may he found in the quality of the milk supplied by them. It will be noticed that in some towns, and particularly in Poona, the number of cows kept is very considerable, but it is believed that this is attributable to the fact, not that the owners prefer cows' milk or find the cow a more economical animal, but that these owners are private individuals who simply keep a milk animal for their domestic milk supply and find that it involves far less trouble to their family to keep a single cow than to keep a single buffalo. As regards the actual economy, under varying conditions, of cows and buffaloes, we have not got much positive evidence, but the following figures obtained during the past year at the Agricultural College Dairy at Poona show the *feed cost* (fodder and concentrated food) necessary to produce 100 lbs. of milk and one lb. of butter fat from cows and buffaloes, respectively. In each case four selected animals were taken of the breeds which have been found most profitable in Poona, *viz.*, the Sindhi breed in the case of cows and the Surti breed in the case of buffaloes.

	Live weight	Annual yield of milk	Percentage of butter fat	Total butter fat	Cost of fodder	Cost of concentrates.	Total cost of feeding	Feed cost to produce 100 lbs. of milk	Feed cost to produce 1 lb. of butter fat
	lb.	lb.		lb.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.
Sindhi cows.									
Begum . .	1,000	2,345	5·3	124·28	83 6 7	54 14 3	138 4 10	5 14 4	1 1 0
Zankar . .	600	3,344½	4·2	140·44	83 6 7	63 10 7	147 1 2	4 6 4	1 0 9
Flora . .	800	3,261¼	5·0	160·07	83 6 7	76 2 0	159 8 7	4 15 9	0 15 11
Changuni .	800	2,736¼	4·8	31·3	83 6 7	68 6 5	151 13 0	5 8 9	1 2 5
Total .	..	11,627¾	..	556·11	333 10 4	263 1 3	596 11 7	5 2 3 Average.	1 1 2
Surti buffaloes.									
Agaj . .	1,200	3,294¾	7·5	274·12	121 13 1	85 11 10	207 8 11	6 14 9	0 13 5
Lawanji . .	1,170	2,906½	7·7	223·80	121 13 1	80 5 6	202 2 7	6 15 3	0 14 5
Sajani . .	1,200	2,250	7·8	175·50	93 7 1	64 0 7	157 7 8	7 0 0	0 14 4
Shitap . .	1,100	3,452½	7·4	253·22	121 13 1	81 12 6	203 9 7	5 15 4	0 12 10
Total .	..	11,903½	..	926·64	458 14 4	311 14 5	770 12 9	6 7 7 Average.	0 13 8

These figures show that in the matter of milk production, irrespective of the quality of the milk, the cow is more economical than the buffalo by 20 per cent, while in the matter of butter fat production the buffalo is 21 per cent more economical than the cow. The general experience of the Military Dairy at Poona which works with Sindhi cows and Delhi buffaloes is similar; and though these figures cannot, of course, be taken as applicable to all breeds, they may be taken as indicating the relative value of cows and buffaloes to a man who is working with good animals of a good breed. The Agricultural Department have not worked with many breeds at the College Dairy but have tried Deccani buffaloes and if the figures for Deccani buffaloes (the poorest milkers of the lot) were to be substituted for Surti buffaloes, it would be found that the Sindhi cow was the more economical animal not only for milk production but also for fat production. It would, however, obviously not be fair to compare the best breed of cows with the worst breed of buffaloes, and it is probable that if it were possible to compare the figures for the generality of cows with the generality of buffaloes it would be found that the advantage of buffaloes over cows would be much greater than the above figures indicate, for there are some breeds of cows which afford no milk beyond that required for the calf, and many cows of many breeds which give a very small surplus quantity. It may well pay a milk producer who caters for a public which prefers cows' milk or which is satisfied with a fat content of 4 to 5 per cent to keep cows in preference to buffaloes, but so far as the general Indian public is concerned, both on grounds of economy and on grounds of preference, the buffalo appears to be the animal to which we must look for the main milk supply. We understand that on the military dairy farms they are now effecting a great increase in the milking capacity of cows by the importation of English bulls of good milk strain, but in view of the fact that these bulls are delicate and that both they and their progeny are very susceptible to disease, we consider that this expedient is not at present suited to ordinary Indian conditions, and have excluded it from our consideration.

10. *Milk Supply Agencies.* In paragraph 2 we have indicated in general terms the extent to which the milk consumed in cities is produced within the cities or is brought into the cities from outside. The milk produced within the cities comes from animals which are kept either by private individuals for their own use or by gowlis on a commercial basis. The conditions of many Indian cities are such that some persons within city limits have gardens or yards of considerable size and have adequate facilities for keeping an animal or two. Such an arrangement accords with the convenience and sentiments of the owners, and subject to absolute sanitary necessities (discussed hereafter), we see no reason why such persons who keep one or two animals for the domestic supply of milk to themselves and their friends should be interfered with in any way in the production, handling or sale of such milk. The great bulk of the town population, however, have no such facilities, and it is possible that if a good milk supply were otherwise obtainable, some of the persons who now go to the trouble of keeping their own milch animals in the cities would cease to do so.

11. The town gowli who keeps a herd of animals in or close to the town corresponds to the town dairyman in England, who has now almost disappeared as a result of the effective arrangements that are there made to bring milk into cities from a distance. As an institution he has his merits and his defects, but in the absence of effective arrangements for the transport of milk he is a necessity. His merits are that he meets a demand for milk which

under present arrangements, could not otherwise be met and makes it possible for a customer who takes the trouble to see the milk drawn to satisfy himself that he is getting pure milk. His defects are :—

(i) By keeping a large number of animals in a densely populated area his operations are in some cases inimical to the sanitary requirements of the locality and conduce to the contamination of his milk by pathogenic bacteria.

(ii) Being a dairyman, pure and simple, and not a farmer, he has to purchase all the fodder and concentrated food for his cattle at the enhanced prices which such articles always fetch in towns, and is seldom in a position to obtain any considerable amount of grazing, free or otherwise, for his cattle. The expenses thus incurred necessarily send up the price of the milk which he retails, and sometimes drive him to feed his cattle on foul horse litter.

(iii) The animals are kept in unnatural conditions with accommodation, which is often insufficient and inferior to that which is usually provided in rural parts. This is apt to react unfavourably on the animals, prevents regularity of breeding and makes it unprofitable to rear the calves that are born in such conditions.

(iv) Much of the manure produced by the city herd fails to find its way back to the fields where it is needed.

12. In connection with these matters which we have considered in some detail we are prepared to express the following opinions. It has been proposed in some cities to induce or compel town dairymen to remove their cattle beyond the limits of the city, and the Sanitary Commissioner expressed his objections to the presence of cattle in cities on the ground that they cause overcrowding, that in some cases they habitually feed on human excrement in the town latrines or in the outskirts of a city, and that they add to the excremental contamination of the soil. We quite agree that it is desirable to take steps to prevent milch cattle from feeding on excrement and to exclude herds of cattle from densely populated town areas ; but there are often areas within city limits which are not densely populated and we think that in such places the presence of milch animals may be permitted, provided that ordinary rules of sanitation are obeyed, and would point out that within city limits the existence of an adequate water supply will often provide facilities for cleanliness which do not occur outside the city, and that sanitary regulations can be more easily enforced inside a town than outside. The great advantage that the town gowli obtains is that he can market his milk at his own door and is saved the expense of transport of milk. It is obvious, therefore, that it will penalise him considerably if he is moved to a considerable distance, and it is unlikely that in the vicinity of a large town he will be able to obtain much compensation in the way of free grazing. The success of any scheme for moving gowlis outside a town will depend greatly on the choice of the localities to which they are moved. If a site can be found which does not make the marketing of the milk too laborious and which at the same time provides better accommodation and some degree of grazing facilities, such a scheme has much to recommend it ; but if these objects are not secured, the result will be to make the gowlis' business less remunerative, and so to raise the price of his milk. Subject to the above considerations we agree with the principle of excluding herds of cattle from densely populated areas.

13. A very unsatisfactory feature of the town gowlis' business arises from the unnatural conditions under which he keeps his animals. Except in Upper Gujarat the gowli is not essentially a cattle breeder, but usually purchases buffaloes in milk and keeps them as long as they remain in milk. In some cases he has no facilities or no desire to get the animals covered when they come in season. It is thought by some that the conditions under which she-buffaloes are kept by town gowlis tend to produce irregularity of breeding, but whether or not the animals come in season under such conditions with as much regularity as they do under normal conditions, the period is less likely to be noticed, and consequently the animal less likely to be covered, even if a bull is available for the purpose, than would be the case if the animals were out at grass. The result is that many good milk buffaloes finish their period of lactation without having been covered and must therefore remain dry for a period of at least 10 months, possibly much more. The town gowli is seldom in a position to keep dry animals economically, and therefore will be likely to sell such an animal for what she will fetch. It is thought by some that, as a result of this, good milk buffaloes go to the butcher, which under normal circumstances would continue to breed. The tendency must be in this direction, and this used to be a common feature of the business of town dairymen in England. There are, however, everywhere a number of old and unprofitable animals which are fit for nothing but slaughter, and except in the case of Bombay City we have no evidence that the number of she-buffaloes slaughtered exceeds the normal number of animals which need to be cast. If by locating the gowlis outside cities and organising them in any way, a means can be found to provide them with good bulls and with some facilities for the grazing of dry animals, it will do something to mitigate this evil in so far as it exists in the mofussil. In Bombay City the case is different. We understand that the number of she-buffaloes to be found in Bombay at any one time is about 20,000 which probably means that in the course of the year about 30,000 she-buffaloes are brought to Bombay, mainly from Gujarat and Kathiawar. Of these 30,000 it might normally be expected that about 3,000 would be cast : but in point of fact we find that a much greater number than this are slaughtered in Bombay. The figures for 1914-15 show that the following numbers of she-buffaloes, all said to come from Bombay City, were slaughtered :—

Bandra slaughter-house	8,500
Kurla (The flesh of the animals slaughtered at Kurla is said to be used for the Burma dry meat trade)	5,000
Total	13,500

This indicates that the conditions of Bombay result in the annual slaughter of some 10,000 profitable milch buffaloes. Apart from the reasons already mentioned there appear to be in Bombay some special causes of this, viz., there is in Bombay a large demand for buffalo meat for the food supply of certain classes of the population and for use on ships, and we understand that the rules of the Bombay Municipality prohibit the slaughter of male buffaloes or the import of meat to the city and port except from the Bandra slaughter house. These rules artificially enhance the value for slaughter of dry buffaloes in Bombay, and must tend to accentuate this undesirable feature of the town dairyman's business. The number slaughtered is not, of course, a large proportion of the stock in Gujarat and Kathiawar, and we believe that the very best animals are not sent to Bombay, and that of the animals which do go to Bombay the gowlis make arrangements to send back some of the best milkers to Gujarat when they are dry, while a class of dealers make a regular practice of buying up dry buffaloes cheap in Bombay and taking them to the grazing grounds of the Konkan and the Deccan ; still, seeing that there is in many rural areas in close connection with Bombay an abundance of unprofitable buffaloes useful only for slaughter, it is unfortunate that any she-buffaloes of value as milch animals should be slaughtered, and we consider that steps should be taken to minimize the evil. This might be done by—

(1) organizing or facilitating the export of valuable dry buffaloes from Bombay to grazing districts,

(2) arranging for the import of buffaloes' meat into Bombay,

(3) locating the milk animals outside the city, and importing milk from a distance.

14. Another evil connected with the town gowlis' business relates to the treatment of the calves, and this is far more serious since it applies not only to Bombay but to all large towns. The town gowli wants the buffaloes' milk and he does not want the buffalo calf, which he is unable to rear profitably. As a result he allows the calf to die of neglect, or in some places hastens matters by throwing it alive into a dust bin. This means the loss to the country every year of large number of calves of the best milk buffaloes. It is a natural result of the circumstances of the town gowli and will disappear in proportion as the town gowli disappears.

15. The last source of the milk supply of large cities consists of the supply obtainable from villages where the cultivators keep one or more milch animals apiece. This source of supply has been developed to a considerable

extent in Gujarat but very little in the Deccan. We have no hesitation in saying that such animals are kept under the most natural conditions and that in this way milk can be produced most economically. We believe that if this supply is properly organized and developed it will be found ample for the supply of large cities.

16. We propose to discuss in the next chapter the best method of making this supply available, and under the present heading it only remains for us to deal with one more matter. It has been suggested in recent years that what is needed to improve the city milk supply in this country is individuals or companies which will take up the matter on a large scale and with modern appliances. In this connection it is desirable to mark the difference between dairy farming concerns which aim at producing the supply of milk which they propose to put on the market and dairying concerns which merely aim at buying milk in the country and putting it on the town markets by improved methods. As regards dairy-farming concerns we understand that there are a few such in the Presidency, but the production of milk on these lines is necessarily costly, particularly so when such concerns are situated in a town. The experience of the Military and Civil Dairies in Poona has been that the cost of producing pure milk on sanitary lines works out very high under such conditions. It is found that in Poona milk can be produced at a profit by such an agency and sold at the rate of 2 annas a lb. (delivered) containing 5 per cent. butter fat. If a large dairy-farming concern is situated in the country and can command good grazing facilities it can doubtless produce the milk at a cheaper rate, but it is believed that the difficulty of obtaining large blocks of suitable grazing land without detriment to the rights of the existing inhabitants of the locality is considerable. It is not to be expected that milk can be produced in this way as cheaply as it can be produced by the small cultivator, and it is doubtful whether much relief can be expected from this source.

17. As regards dairying the matter is different, and we believe that much can be done by individuals, societies or companies in the direction of establishing milk buying agencies in suitable districts and in arranging for the handling and transport of the milk to cities by suitable methods. As an example of this we may mention the case of the "Indian Dairy Supply Company" which has established a buying agency at Nadiad and aims at placing on the Bombay market (at a distance of 281 miles) 1,000 gallons of pasteurised whole milk and 500 gallons of pasteurised separated milk daily. We believe that by such methods the supply of milk to cities can be greatly improved and we propose to deal with the possibility of such developments in the next chapter.

CHAPTER III.

THE BEST METHODS TO INCREASE THE SUPPLY AND IMPROVE THE QUALITY OF THE MILK OF LARGE CITIES.

18. This consideration involves two distinct questions which are, however, so dependent on each other that it is necessary to consider them together. The problem may be considered in two different lights, in one of which milk appears as a valuable and desirable food and the other in which it appears as a dangerous source of infection. In Europe there are two matters which give special importance to the milk problem, *viz.*, the extensive practice of artificially feeding infants, and the presence of bovine tuberculosis. In India the first is of much less importance and the latter is certainly uncommon. Considering milk as a food, the Sanitary Commissioner emphasized the necessity of breast-feeding for infants as opposed to artificial feeding. He regarded milk as a valuable food for older children but noted that it was bulky and expensive, and regarded it as a question whether proteid could not be better obtained for older children and for adults from cereals and pulses, than from a dear and doubtful milk supply. He stated that the fat in milk was a very valuable food but was dear, and that the fat obtained from vegetable oils was equally effective though not so palatable; while the mineral constituents of milk can be obtained equally well from yolk of egg, rice, wheat, fruit and vegetables. Finally he expressed the opinion that the faulty methods under which milk is habitually produced and handled in this country detract much from its value as a healthy food and constitute a danger to health, though he had no evidence of any connection between bad milk and the high mortality of children from dysentery, which mortality he attributed to excremental contamination of the soil producing indirect contamination of food and water. Accepting the view that milk is dear and liable to contamination, the fact remains that it is a very valuable food and one much desired by all classes of Indians. We believe that the price of milk in cities can be reduced by the adoption of effective methods, and we are of opinion that such measures as conduce to this end should be taken.

19. It is possible also to suggest measures calculated to improve the quality of the milk supply and to obviate the risk of contamination. Unfortunately the adoption of some such measures has a tendency in the first instance, at any rate, to enhance the price of milk, and so to neutralise the efforts at cheapening it which we regard as of primary importance; and we consider that any general measures which have this tendency must be postponed until the milk supply of towns has been established on a firm basis, when we believe that it will be possible to introduce sanitary control without any disastrous effect on the supply. We recognize that in taking this attitude we lay ourselves open to the charge that we are proposing to put upon town markets a large supply of milk without being able to guarantee its purity or control the conditions of its production. We admit this, but consider that, speaking generally, its value as a food outweighs its dangers as a source of infection. There is little evidence that at present much disease in Indian cities can be traced to milk though a large part of the supply is undeniably impure. We quite recognize the value of sanitary measures which enlightened public opinion will accept and which can be uniformly enforced, but when the people ask for cheap milk it is no substitute to offer them dear milk coupled with sanitary regulations. In any case we believe that the very general practice in this country of boiling milk before use greatly minimizes the risk of its conveying disease.

20. We have already stated in Chapter II that the most promising source of milk supply for towns lies in the villages where cultivators keep their animals under natural and economical conditions. It is from such sources that an adequate supply of milk has been secured for the cities of other countries. The transport of milk is, no doubt, a more difficult matter in hot countries than in cold owing to the rapidity with which milk goes bad; but such difficulties are overcome in high temperatures in the United States, and for some time past pasteurised milk has been sent without difficulty from Poona to Bombay (distance 119 miles). It is lack of organization which prevents the adoption of such measures in India. We believe that the village milk supply of Gujarat is ample to provide for the cities of Gujarat and Bombay City, and in parts of the Deccan conditions appear to be most favourable though each case must be considered on its own merits.

21. Take the case of Poona which at the present high price of milk (8 lbs. per rupee) consumes only 25,000 lbs. of milk a day, but which would take a much larger quantity at a cheaper rate. Only ⅕th of this milk supply is brought in from outside, and that is brought in by hand by some 350 men who carry about 16 lbs. apiece. Comparatively little comes from a distance of over six miles and none from a distance of more than 9 miles. By train a negligible quantity of 120 lbs. a day is all that comes. Now Poona is surrounded by villages containing considerable grazing areas, and the main crop grown in the neighbourhood is Jowari, which supplies good fodder. There are good irrigation facilities on two sides, and the town is served by eight good roads and two railway lines. Seeing how high the price of milk is in Poona it might be expected that many cultivators in the neighbouring villages would see their way to make a good profit by producing milk for the Poona market. The fact that they do not do so can be attributed only, we believe, to the cost of transporting a small quantity daily to the market and the worry of retailing the same. We believe that if collecting agencies were organized at suitable places, which would enable cultivators to market their milk without difficulty near their own homes, and would arrange for the effective and economical transport of the milk to the cities, a good supply could be obtained at a cheaper rate. We are informed that at Talegaon which is 20 miles distant from Poona and connected with it by good railway service there is a good supply of milk available at 20 lbs. per rupee or (roughly) 10 pies a lb. and that in the villages round the fort of

Sinhagad at a distance of 12 to 15 miles from Poona, and connected with it by the Satara and Sinhagad roads, a good supply of milk can be obtained at rates which now stand at 24 lb. per rupee from January to June and at 32 lb. per rupee from July to December. This milk is now used mainly for making *mava* (dessicated milk), since with the present arrangements whole milk cannot be brought from such distances to the market. Turning to more distant sources of supply it has been brought to our notice that the south of the Satara District and the country round Sangli (distance from Poona 166 miles) already maintain a dairying industry of considerable magnitude, some of the villages keeping 400 or 500 good milk buffaloes. At present the great bulk of this milk is used for *ghee* making, and Rs. 5 lakhs worth of *ghee* is said to be exported annually from Sangli Station alone. The present price for rich milk in the villages of this tract is said to be 20 to 22 lb. per rupee according to the season.

22. Now it may be argued that when a buying agency is established in any tract it will send up local prices. This is no doubt the case, and has occurred in the tracts of Gujarat where such agencies have been established, to the great advantage of the cultivators, who produce milk; but it has also been found that the presence of a buying agency which facilitates the *marketing of small lots and pays a somewhat better price, increases the supply of milk*; and we wish to lay emphasis on the fact that the supply of milk in any locality depends largely on the demand, and can usually be much increased at will. The prices of *ghee* and *mava* do not admit of a better price than about 32 lb. per rupee being paid for milk, and although in the case of *ghee*-making the buttermilk remains with the cultivator, this is a very unprofitable way to market milk if any method of selling whole milk is available. We believe that the marked difference in prices which is found in the towns and in the rural parts, respectively, will, in suitable localities, admit of such buying agencies being established and worked at a profit, while operating so as to increase the supply and reduce the price of milk in towns and to pay the milk producers a better price than they now obtain.

23. It has been suggested that in tracts which do not admit of easy marketing of milk and where *ghee* is now produced, steps may be taken to manufacture a half-dry curd and put it on the town markets. From 100 lb. of separated milk about 40 lb. of half-dry curd can be prepared, and the latter would be more portable and less perishable than the former. We understand that this is already done to some extent, but that the curd is not much appreciated since it lacks the flavour of the preparations of this nature which contain the whey. We cannot say how far larger quantities of such curd would find a ready market but the matter is worth consideration, as the curd would contain the bulk of the albuminoid parts of the milk and would constitute a valuable food for the poorer classes if it could be sold cheap.

24. Where the private enterprise of individuals or companies suffices to take up dairying work, nothing is called for on the part of public bodies except such general or special assistance as they may be able to afford from time to time; but where such enterprise is not found, we would suggest that the Municipality interested should promote the matter by offering some assistance. The exact nature of the assistance required will depend on local circumstances, but we note the fact that Government have expressed their willingness to make advances to Municipalities which contemplate action of this kind [*vide* G. R. No. 7706 of 25th October 1913, G. D., and G. R. No. 5644 of 18th July 1914, G. D. (paragraph 21)].

25. It is a matter of common knowledge that in other countries striking developments in the dairying business have been effected by the agency of co-operative societies, and we are of opinion that much progress may be made in this country by means of the same agency. In such matters as the financing of the milk producers, the joint purchase of feeding stuffs and the collection of small lots of milk there is no doubt that a co-operative society can be of much use. There is evidence that a co-operative society can undertake on a small scale the marketing of its own milk in a neighbouring town where the distance is not great, but doubts have been expressed whether a co-operative society is a suitable agency to undertake the more difficult task of handling milk for long transport or the work of retailing milk on a large scale, which demands a degree of care and activity not often found except where the retailer's personal interests are concerned. Co-operation cannot be regarded as a substitute for efficiency, and if efficiency is to be secured, the enterprise in each case must be large enough to afford the cost of capable management. The question how far co-operative societies should go in this matter, must, therefore, depend on the degree of efficiency which they can command and the question whether there are other agencies available to continue the work at the point at which they might feel disposed to leave it. We append a report of the Assistant Registrar, Co-operative Societies in the Bombay Presidency showing the work of this kind which has been done in this Presidency, and a report of the Registrar of the Co-operative Societies in United Provinces showing the work which has been done there (appendices A and B). We also append an estimate prepared by Mr. G. H. Frost, Assistant Director, Military Dairies, Southern Circle, showing the cost of establishing a collecting station for about 2,000 lb. of milk daily, for pasteurisation and despatch by train or motor to a distance not exceeding 50 miles (appendix C); and we believe that this is the smallest amount of milk which could afford the cost of the superintendence necessary for an enterprise of the kind contemplated.

26. Turning now to the consideration of measures for the improvement of the quality of the milk sold in cities, we believe there is in many towns a limited demand for superior milk at a price somewhat above the normal. Where this is the case and the Municipality has a Health Officer and a staff capable of undertaking the work, we recommend the following scheme for putting on the market a "Certificated milk," which is calculated to pave the way for a general system of milk control in cities.

Rules for Certificated Milk Suppliers.

(1) Every Municipality which is furnished with a Health Officer and a man capable of analysing milk may certify milk the producers of which voluntarily submit to inspection and control.

(2) Every producer who wishes that his milk shall be certificated shall apply to the Chief Officer of the Municipality, who will inform him of the conditions which have to be fulfilled before such certification can be given.

(3) The conditions of certification would be something like the following:—

(*a*) The producer's stables, dairy and milk to be subject at any time to inspection by municipal officers;

(*b*) The stables to conform to the standard laid down by the Municipality in point of construction, space and ventilation;

(*c*) The stables to be kept in clean and wholesome condition;

(*d*) The milch animals to be certified as healthy by competent veterinary authority;

(*e*) The milking vessels to be scalded before milking, the udders of the animals cleaned and the whole operation conducted under clean conditions:

(*f*) The milk to be transferred and delivered in vessels into which dust and dirt cannot penetrate, and of the character prescribed by the Municipality. If the milk is sold from a shop, the shop to be subject to inspection;

(*g*) A test to be made from time to time against adulterants and preservatives of all kinds;

(*h*) A simple dirt test to be made from time to time;

(*i*) A purity test to be made from time to time to ensure that the milk comes to the following standard, viz:—

	Fat per cent.	Total milk solids per cent.
Buffaloes' milk	5½	14½
Cows' milk	3½	12

Inasmuch as the bulk of city milk supply comes from buffaloes, it is desirable to guard against fraud on the part of milk sellers who might adulterate buffaloes' milk heavily and then claim that it was cows' milk, and so avoid any penalty. In cases, therefore, where a man is found selling milk of a low grade which he claims to be cows' milk it will be for him to give satisfactory evidence that it is really cows' milk and not adulterated buffaloes' milk.

It will be noticed that this scheme is permissive only both to the Municipality and to the milk seller. The certificate would be to the producer and not to any particular lot of milk, and would be withdrawn if the producer were found not to be conforming to the conditions. The list of certificated producers might be announced publicly, either by the Press or otherwise and any withdrawal of certification announced in the same public manner.

27. While we have expressed our opinion that under existing circumstances a system of "certificated milk" can be introduced for people who are prepared to pay rather higher for a pure article, we would again refer to our opinion already expressed that it is imperative to do nothing to further enhance the general price of milk since a large part of the town population cannot afford it at present prices. In view of the evidence which has been given of the gross adulteration practised in towns both by the producers and by the milk sellers we think it incumbent on us to suggest a general standard of purity which Municipalities *may* adopt as a condition of selling milk in towns, but we wish it to be clearly understood that we do not recommend its adoption by any Municipality until such time as it has secured a good supply of milk established on a safe basis and until it has a competent and trustworthy staff to enforce the rules without unnecessary friction. Subject to these considerations, we recommend that the standard of purity set forth above in No. 3(i) of the rules for certificated milk be adopted as a general standard. Though a purity standard may not at present be suitable for general adoption, we believe that the organization of city milk supply on the lines which we have indicated by collecting agencies which pay for the milk on a purity basis will do much to check adulteration, and that in time it will be found possible to adopt a purity standard as a condition of selling milk in towns.

28. Under the existing law powers to control the milk supply are contained in sections 48 and 142 of the Bombay District Municipal Act. If the above recommendation is accepted, it will be necessary to amend these sections so as to give Municipalities the power to enforce a general purity standard. We think that any such amendment should follow the lines of the English enactment which provides that when milk is found to contain less than X per cent. of milk fat or less than X per cent. of milk solids other than fat, it shall be presumed that the milk is not genuine by reason of abstraction therefrom of milk fat or milk solids, or the addition of water. Failure to comply with the standard would then entail prosecution. It is necessary also to make it clear that all milk sold shall be presumed to be unadulterated milk from which fat has not been removed, and it must not be open to any one to escape from the regulations simply by stating that he does not profess to sell pure milk. Any Municipality, however, should have the power to license definite people to sell separated milk, or such special preparations of milk as may be considered desirable.

29. It was suggested that Municipalities should have the power to trace their milk supply to its source, and we recognize that there is much to be said for the "permit system" in force in the United States of America, according to which permission to import milk into a town is given only to such persons, wherever situated, as will accept the municipal inspection and control of their methods of producing and handling the milk, but we consider that under present conditions in India, where it would be necessary to deal with a large number of small producers, the difficulties of introducing such a system would be insuperable. We believe, however, that it is desirable that a Municipality should have power to purchase land outside its municipal limits on which it can erect cattle sheds for gowlis and over which it can exercise supervision. In cases, too, where a large supply of milk comes into any city from the immediate neighbourhood but outside municipal limits it may be desirable to grant to a Municipality, having a strong staff, powers to inspect and regulate the cattle sheds and the methods of producing and handling the milk within this limited area. In this connection we would call attention to the fact that the principal reason for observing cleanliness in the stables is to protect the milk from contamination. Where therefore arrangements are made for clean milking sheds in which the milk is drawn, and for washing the animals and the milkers before the milk is drawn, it is not necessary to be too scrupulous about the design or extreme cleanliness of stables, unless they are so situated that they are liable to constitute a danger to the health of human beings living in the immediate vicinity. We think that Municipalities might secure sanitary advantages and facilitate the working of the proposed rules for "Certificated milk" by providing suitable milking sheds with a supply of good water; and this remark applies in particular to towns where the existing practice is to bring cattle daily for milking to definite stands, where at present the conditions are said to be anything but cleanly.

30. We are unable at present to recommend any bacteriological standard for milk; but the attention of Municipal Health Officers should be called to the desirability of making microscopic and bacteriological examination of samples of milk. When the milk of any milk seller is found to contain bacteria whose presence indicates manurial or other detrimental pollution, the matter should be enquired into with a view to further action. If such a milk seller were "certificated" his certificate should be withdrawn until the cause of infection was removed. If it were demonstrated that milk dangerous to the health of the community were being brought into towns from certain areas it would be desirable for Government to take legal powers to enable municipalities to exclude milk coming from such areas.

CHAPTER IV.

THE TECHNICAL SIDE OF MILK PRODUCTION.

31. In dealing with the technical side of milk production the most striking fact is the very low yield of milk per animal obtained in India as compared with the yield obtained in Europe, and we propose to consider this briefly with reference to possibilities of improvement in breeding, feeding, housing and tending.

32. It is well known that in Europe pedigree strains of milch animals have been produced by careful and long-continued selection, and it is there open to any dairy farmer to increase the yield of his herd by procuring the service of a good pedigree bull. The dairy farmer in this country has no such resource since pedigree bulls are practically unobtainable. Buffaloes have been bred mainly for milk purposes, and there is on the whole less variation in the milk yield of individual buffaloes than of individual cows. In some breeds of cattle, notably the Karachi and Gir breeds, a relatively high standard of milk production has been obtained; but even amongst those the individuals vary enormously, and without knowing the breeding of any bull there is no certainty regarding the milking capacity of his offspring. The Government dairy farms, Military and Civil, have confined themselves mainly to milk production on a commercial basis, and though they have done their best to obtain good bulls it cannot be said that they have effected any marked improvement by breeding, much less can it be claimed that they have produced pedigree stock. Indeed in the case of the College Dairy at Poona the tendency is for the animals bred on the farm to deteriorate in milk yield below the standard of their mothers, and the average of the herd is kept up only by the addition of new stock from outside. We would point out that the building up of pedigree stock requires expert knowledge and sustained effort, and we consider that a systematic start should be made in this direction. We understand that a scheme is now before the Government of India for taking up the question of breeding in different parts of India and we would urge that no time should be lost in starting it upon a sound and adequate basis.

33. In the matter of feeding we believe that in the best milk producing tracts (*e.g.*, the country round Nadiad and Sangli) cultivators feed their buffaloes very economically. It is commonly contended that extensive free grazing is necessary for cheap milk production, but such is not found to be the case in many of the best milk-producing tracts; and we believe that it is not possible to make any considerable addition to the area of common grazing.

Common grazing is a great convenience to small holders, where it exists, and even as an exercising ground for the village herd the land usually set apart for cattle deserves preservation, but extensive common grazing cannot be considered an economical practice, and it is certain that good land can produce more fodder to the acre under cultivation than under the neglected and unimproved condition of the common grazing ground. The great trouble that the cultivators have is not so much to find forage during the rains as during the dry season. There can be no doubt that the milch animals habitually suffer from want of adequate fodder and water towards the end of the dry season, and even in the best milk producing districts of Gujarat, there is a drop in milk production of 20 or 30 per cent. during the months of March to June, and in other parts it is well known that the milk supply falls off largely as soon as the green grass comes to an end. To obviate this, larger storage of fodder is essential, both dry and in the form of ensilage ; and we think that the Agricultural Department should do all that they can to encourage this.

34. In connection with the question of housing we do not think that the animals need elaborate accommodation. They need to be protected from the weather, made comfortable and given plenty of fresh air. Under village conditions we believe that they usually get this so far as the means of their owners will allow. In larger dairies stone or cement floors have been recommended as tending to effective sanitation. They certainly do this but the animals find them hard, cold and slippery.

35. We believe that it is a common experience in other countries that the milch animal will tend to give better results in the hands of a careful small holder who treats it as "one of the family" than in a commercial dairy where it is simply "one of the herd." This is certainly so in India. At the College Dairy at Poona, for instance, it is found that there is a tendency for the yield of animals purchased from outside to fall off in subsequent periods of lactation. Both the feeding and housing there are superior to what the animals would obtain in the villages, and we can only attribute this falling off to bad tending. The men usually available for employment in Indian commercial dairies have, as a rule, little knowledge of cattle, and they are frequently bad milkers and careless tenders.

36. For the encouragement of breeding we consider that it will often be of use to station a good "premium" bull in a milk producing tract. In the absence of pedigree stock all that can be done is to get the best bull available. We also think that small shows of milch cattle are to be recommended, starting with single village shows in the best dairying areas or in any collecting area which is being worked in connection with a town milk supply, and that an object of such shows should be to establish mutually advantageous relations between milk producers and dairy men.

CHAPTER V.

THE PRESERVATION AND TRANSPORT OF MILK.

37. If milk can be put on the market within four hours of milking it should require no special treatment. When the time required is somewhat longer water cooling and mechanical cleaning will increase the life of the milk to some extent. Where a considerable period of time is necessary to market the milk there are three methods possible, refrigeration, sterilization and pasteurization. Unless the quantity of milk to be handled is very large, the cost of refrigeration is prohibitive, since the initial cost and the running expenses are high. Sterilization is advocated on sanitary grounds, but the cost including bottling is very high. Apart from the cost, it is doubtful whether it would find a ready market since it is liable to have a peculiar taste, and when homogenized is not suitable for preparing butter, and can hardly be regarded as fresh milk supply. This leaves only pasteurization to consider. Pasteurization will give milk an eighteen hours' life and is cheap, the cost of the process in Poona being only $1\frac{1}{2}$ pies per lb. on a minimum of 3,000 lb. It must be realized that pasteurization is a device for prolonging the life of the milk rather than a measure to be advocated on purely sanitary grounds, since the milk is liable to reinfection by disease bacteria which may develop considerably during the prolonged life of the milk. It remains, however, the only practicable method of which we have experience in India for extending the life of the milk, and as such we advocate it. In the United States of America great stress is laid upon the regulation which provides that milk must not be kept for sale at a temperature higher than 50° F. The object of this is to check the development of bacteria. Facilities do not ordinarily exist for keeping milk down to this temperature in India ; but it is possible that in some towns economical arrangements could be made with an Ice Company to store milk brought into a town until it can be sold. There are many problems connected with the preservation, handling and transport of milk which require investigation with reference to Indian conditions, and in this connection we would invite a reference to the interesting paper on the subject published in the *Agricultural Journal of India* for October 1915.

38. We have no suggestion to make regarding the transport of milk by road. The matter must be considered at any place with reference to existing conditions and facilities. As regards transport by train we append statements showing the rates quoted by the management of the Great Indian Peninsula and Bombay, Baroda and Central India Railways for the carriage of milk in bulk, and consider them to be reasonable (appendix D). Where railway facilities are available they provide the cheapest means of marketing milk from a distance, but, for economy, milk must be marketed in cans in bulk and not sent in small lots each accompanied by a man. At present 45,000 lb. of milk daily are brought into Bombay by train in lots of about 50 lb. or less, and each lot is accompanied by a man ; so that the marketing of this milk consumes the time of a thousand men. When milk is brought into Bombay in this way it is stated that each man and each parcel of milk has to pay the ordinary rates, and that this milk gets no "concession rates" as are granted for unaccompanied milk. It was also pointed out that the men who accompany the milk have to travel by ordinary season tickets which are available for themselves only, so that, if the man for whom the season ticket is taken falls ill or for any other reason cannot travel, a full fare has to be paid, and it was suggested that the Railway Companies might be approached to grant season tickets which would cover any servant accompanying the milk sent in by a definite man. We think that the true remedy is to market the milk in bulk unaccompanied, and have no doubt that in time this will be done ; but to meet the present difficulty we suggest that these matters be brought to the notice of the Railway administrations for the consideration of any relief that they may be able to afford.

CHAPTER VI.

EDUCATION IN DAIRYING AND DAIRY FARMING, AND STAFF REQUIRED FOR INVESTIGATION AND ORGANIZATION.

39. We consider that Government can materially assist the development of the movement to improve the supply of milk to cities by providing facilities for dairy education and by appointing experts to investigate problems and advise the public.

If the development indicated in our proposals is to be secured three courses of instruction will be necessary :—

(1) A course is required to train Municipal Inspectors or prospective Inspectors in milk testing and general dairy sanitation. We think that one month will suffice for such a course and that it could be given at the Agricultural College, Poona.

(2) There is already a demand which is likely to grow, for active (Vernacular speaking) men who know practical dairying, and can undertake work for dairy societies or dairy companies, or who might take up independent dairying work themselves. A course of instruction is required for such men.

(3) A course is required to train men for dairy farming so that they may ultimately become managers of large commercial dairy farms. Such a course could be given at the Agricultural College and the military dairy farms. It would probably be necessary for a man to have two years' theoretical training to be followed by one or two years' practical training on a military dairy farm or a large commercial dairy farm.

It is understood that proposals have been made for the establishment of dairy schools by the Imperial Government, and we think that it is on the lines indicated above that the courses should be projected. We are not aware of the exact nature of the measures likely to be taken in pursuance of the scheme, and are therefore not in a position to make isolated proposals ; but it is essential that a satisfactory agency for giving the required instruction shall be established, since it is upon the technical skill of the operators that the success of an extended dairy industry will largely depend.

40. For investigation and organizing and assisting developments in the milk trade the following staff would be required, *viz.*—

(1) A breeding expert. It is understood that in the scheme referred to above it is proposed that the Imperial Government should provide such a man.

(2) A dairy expert for investigation and giving assistance and advice to the public.

(3) Additions to the staff of the Registrar of Co-operative Societies for organizing and assisting milk societies.

CONCLUSION.

41. The supply of good milk at a reasonable rate to the cities of the Bombay Presidency is thus a complicated problem, but we consider, as we have indicated, that it will ultimately be solved by the organization of supply from cultivators or others keeping cows and buffaloes under natural conditions at a distance (often at a far distance) from the town, and by improvement of transport which will make it possible to place such milk on the market in good condition. It would seem, however, that the method of organizing the supply, the part which professional gowlis should play in it, the extent to which co-operative agency can be used in doing it, the extent to which the Municipalities could and should take active steps in the removal of milch animals to more healthy surroundings in thinly populated areas, and a number of other questions are matters on which data do not really exist for definite recommendations applicable at present to any particular case. We would, therefore, suggest that, with a view to dealing with these questions and realizing more exactly the difficulties which will arise and how they can be met, a single large city should be selected, the whole question of its milk supply investigated, and the most suitable directions for its improvement worked out at the cost of Government. The Municipality should then be approached and the suggestion be made that it should undertake the organization of its milk supply on the lines laid down in the report of this Committee, and as indicated in detail by the investigation made. Since such a trial would be largely experimental, and would serve to clear the way for other Municipalities which may afterwards take up the matter, we suggest that Government should, by grant or guarantee, take upon itself part of the cost or risk of such a pioneer undertaking.

G. F. KEATINGE.
HAROLD H. MANN.
G. K. WALKER.
V. H. GONEHALLI.
A. H. SPEARMAN.
G. K. KELKAR.
S. V. SHEVADE.
Thos. R. LAWRENCE.
W. REEVES.
म. गो. अभ्यंकर. (Subject to the note of dissent already sent to Director of Agriculture.)
HARILAL DESAIBHAI DESAI.
LEMUEL L. JOSHI.

APPENDIX A.

A BRIEF NOTE ON CO-OPERATIVE DAIRY SOCIETIES IN THE BOMBAY PRESIDENCY.

1. Alibag Co-operative Dairy Society, Ltd. Date of registration, 23rd April 1915.

Number of members 35, of whom 28 are cultivators producing milk and marketing it through the Society.

CAPITAL Rs. 1,152-8-0.

Villages from which milk is obtained ; Veshwi and Mula, which are at a distance of 2 miles from the town of Alibag.

Method of collecting, transporting and distributing milk.

The Society has put up two milking sheds at a cost of Rs. 340—one at Veshwi and the other at Mula. The members keep their animals in their own houses, but bring them to the Society's milking sheds twice a day at the appointed hours in which they milk them under the supervision of the representatives of the Managing Committee. The work of supervision is done at Veshwi by the clerk of the Society and at Mula by a member of the Managing Committee. The Society keeps its own milking pails, and one is given to each member for drawing the milk of his animals into it. The milk thus drawn is measured and handed over to the Society. Each member carries a pass book with him, in which the quantities supplied by him to the Society are regularly entered. All milk thus collected at each centre is put in a big brass can, which is locked and sent to the town on headload with a servant of the Society for delivery to registered customers.

Cleanliness. All the pails, cans and other utensils of the Society are kept in a perfectly clean condition. Every utensil used in handling milk is first washed in cold water, then in warm water with some washing soda in it and finally in boiling water and dried. Before milk is drawn from the animals, the hands of the drawer and the udders of the animals are washed and rubbed with muslin. Bar-soap is kept and freely used.

Total number of customers :—76 ; and the total quantity of milk supplied to them in September 1915 was 2,700 seers. All milk taken by the Society from the members is distributed to customers and no surplus is left on hand.

Advantages to the members. The Society takes milk from the members at a little over nine seers a rupee and supplies it at eight seers a rupee to the customers. After deducting expense, a small margin of profits (about Rs. 6) is left to the Society. Though the members are prevented from adulterating their milk with water, they get good prices and save a good deal of time, which they used to spend before joining the Society, in hawking about their milk. They are entirely satisfied with the prices which they now get. Besides, they get loans from the Society at 9⅜ per cent. for purchasing animals and foodstuffs.

Advantages to customers. The public of Alibag are fully satisfied with the quality and the rate of price of the Society's milk.

Other remarks. The Society is now arranging to keep a good buffalo breeding bull for serving the members' she-buffaloes. It has also secured some grazing land from the Collector for the use of the members' she-buffaloes which with the bull proposed to be obtained from Gujarat are to be constituted into a herd.

2. Belgaum Co-operative Dairy Society, Ltd.—

This Society consist of 24 members, of whom 20 are milk-producing gowlis and supply their milk to the Society. The gowlis at present keep their animals in the town and bring them to two milking centres for milking them under the supervision of the manager. The arrangements as regards cleanliness and the collection, transport and distribution of milk are similar to those of the Alibag Dairy Society. The Society has applied to the Municipality for building a shed outside the town for housing the animals of the members of the Society. The Belgaum Dairy Society markets about 3,000 seers of milk a month. The public of Belgaum are entirely satisfied with the quality and price of the milk.

3. Thana Co-operative Dairy Society, Ltd.—

The Society has got a shed in which some animals of the members are kept; other members keep the animals in small huts near the Society's shed. Milk is drawn in the presence of the manager. The arrangements as regards cleanliness and transporting and distributing milk are exactly on the lines of the Alibag Society. The total quantity of milk marketed by the Society every month is about 6,000 seers. The Thana people are fully satisfied with the quality of milk. In this Society, some of the producing members are gowlis (Bhayyas) and others non-gowlis. The Society has got more than 200 families as its customers.

4. The Gomatipur Co-operative Dairy Society near Ahmedabad—

This Society has only very recently begun to supply pure and unadulterated milk to the city of Ahmedabad. The producing members are cultivators.

A proposal for starting a dairy society of cultivators at Asarwa for supplying pure milk to Ahmedabad has been received.

5. The Bhandup Co-operative Dairy Society for supplying pure milk to Bombay is in formation.

6. Proposals for establishing co-operative dairy societies at Gadag and Hubli for improving the milk supplies of those towns are under consideration.

7. Similarly, there are proposals for establishing dairy societies at Kotrud and Talegaon for supplying pure milk to the city of Poona.

V. H. GONEHALLI,

Assistant Registrar,

Co-operative Societies, Bombay Presidency.

APPENDIX B.

COPY OF A LETTER NO. 128 C., DATED 25TH SEPTEMBER 1915, FROM THE REGISTRAR, CO-OPERATIVE SOCIETIES, UNITED PROVINCES, LUCKNOW, TO THE DIRECTOR OF AGRICULTURE, POONA.

With reference to your letter No. A-17647, dated the 14th August 1915, I have the honour to state that there are at present three co-operative dairies in this province. A dairy on a limited liability basis was started in the suburbs of Benares about four years ago. The members are *ahirs*, professional milk sellers. There is a separate credit society on the unlimited liability basis for these members. The premises of the dairy are situated about 5 miles from the city of Benares. The dairy has got a fairly decent shed for the cattle and also for the stocking of feeding stuffs, etc. The dairy society has rented shops in different parts of the city of Benares for the sale of milk and the capital has been raised partly by shares and partly by loans from a public spirited landholder and also from a Central Co-operative Society at Benares. The cattle belong to the members themselves who sell the milk at a fixed price to the society and the society sells the milk again at fixed price for cash to purchasers at the different shops. This dairy did very good business at the beginning and made small profits every year. On the other hand the supply has diminished because owing to a severe fodder famine which has prevailed in the locality for the last two years, the cattle have not been properly fed and the members have also not been able to repay the loans that had been made to them for the purchase of cattle and are consequently debarred from getting fresh loans in substantial amounts to purchase new cattle. Motor transport has been considered but could not be adopted because it has not been possible to guarantee a large minimum supply daily to make the use of a motor remunerative.

2. A second co-operative dairy on different principles has been established at Lucknow during the last two years. In this instance the site is fairly central and lies between the civil station, the city and cantonments of Lucknow. Sheds have been erected for the cattle and also quarters have been provided inside the dairy premises for the residence of the members against whom the cost of each set of quarters is debited in the accounts. The society is on an unlimited liability basis as it not only buys the milk produced by the cattle belonging to the members separately and sells the same either as milk or in the form of butter and cream but also lends money to the members for the purchase of cattle and other requirements. This dairy is financed partly by shares contributed by the members and partly by loans granted by the Municipal Board of Lucknow. During the last two years the society has shown profits in its work. It is too early yet to say whether this institution will be entirely successful but it is a promising experiment.

3. In Allahabad there is a milk selling society of which the members belong to three small hamlets close to the civil station. There are separate credit societies in these hamlets which are open to the members of the milk society as well as to the other residents. The milk society has got a shop and compound where the owners bring their cattle twice every day. The milking is done in the presence of the Manager and the milk is immediately sold to the purchasers. The members here as in the first two cases supply milk to the society at a fixed rate. This society has been going the last three years. Its organization is simple and the cost of contingencies and establishment are kept as low as possible.

4. A fourth society was tried at Gorakhpur on the lines of the Benares Society. In a fifth case in the town of Basti a society has been organized on behalf of the consumers of milk who were to keep cows of their own and sell to the members. This society was closed before formal registration.

5. Our experience has been that the milk selling community as a class are exceedingly intractable and form a very unpromising material for the inculcation of business methods and discipline. It is not proposed to form any more milk societies or co-operative dairies in this province until further experience has been gained in the existing societies.

APPENDIX C.

NOTE ON THE COST OF ESTABLISHING A COLLECTING STATION FOR ABOUT 2,000 LB. OF MILK TO BE PASTEURIZED AND WATERCOOLED, FOR DESPATCH BY TRAIN OR MOTOR TO A DISTANCE NOT EXCEEDING 50 MILES WITH SUITABLY TIMED TRAINS.

	Rs.
Dairy buildings with tiled roof, patent stone floor, gauzed windows and doors, 12′×16′ with wash-up-room 10′×8′ and office 10′×8′ or plinth area 26′×20′=520 at Rs. 3	1,560
Water tank, drains, small pump, etc.	440
Total Buildings	2,000
Boiler vertical cross tube 5″×6″×3′=80 lb. pressure complete with fittings, mounting and No. 4 Injector and 20′ chimney	700
Lawrence Water Cooler	80
"Direct Motor" steam driven pasteuriser size "C," elevating type	550
Milk tank 4′×3′×1½′	80
Gerber Butyrometer Lux. 4 Test Complete	60
Milk Recorder with Pail and Tripod	36
24 "Firsteel" cans, 17 galls., 15 galls., and 10 gallons	500
1 set measures, 1 gallon, ½ gallon 21 lb. and 1 lb.	10
1 Hygea Filter with 500 spare mediums	40
1 Steaming Block	15
1 Wash-up Tank	50
1 Set Seals and Pincers	80
Miscellaneous Contingencies, *i.e.*, stationery, small safe, soap, soda, Lactometers, Thermometers, etc.	300
Total	2,500

APPENDIX D.

COPY OF A LETTER NO. R. 2514, DATED 13TH OCTOBER 1913, FROM THE GENERAL TRAFFIC MANAGER, G. I. P. RAILWAY, BOMBAY.

With reference to your letter No. 2315 of the 5th ultimo, I am prepared to introduce the following rates for the carriage of milk in cans by passenger trains :—

	Rate per maund	Rate per maund for return of empty cans
	Rs. A. P.	Rs. A. P.
Distance :—		
Not exceeding 25 miles	0 2 0	0 2 0
26 to 50 miles	0 3 0	0 2 0
51 to 75 miles	0 4 0	0 2 0
76 to 100 miles	0 5 0	0 2 0
101 to 150 miles	0 6 0	0 3 0
151 to 200 miles	0 7 0	0 4 0

These rates will be subject to a minimum charge of two annas per maund. I shall be glad to hear if these rates will suit you.

2. As regards the question of the provision of insulated vans, the question was discussed at the recent Railway Conference. The North-Western Railway are making some experiments in the matter, and it is proposed to wait the result of those experiments before taking further action.

COPY OF A LETTER NO. COMMERCIAL—R.-2714—2, DATED 10TH DECEMBER 1913, FROM THE TRAFFIC MANAGER, COMMERCIAL, G. I. P. RAILWAY.

Rates for milk in cans and return empty cans by passenger train for a distance of 350 miles.

In continuation of my letter No. R.-2714 of the 6th instant, I have the honour to inform you that I propose to quote the following rates subject to Railway Board's sanction for the carriage of milk in cans and return empty cans for distance of 201 to 350 miles :—

	Rate per maund for milk in cans	Rate per maund for return empty cans
	Rs. A. P.	Rs. A. P.
For distances exceeding 200 miles but not exceeding 250 miles	0 8 0	0 5 0
For distances exceeding 250 miles but not exceeding 300 miles	0 9 0	0 6 0
For distances exceeding 300 but not exceeding 350 miles	0 10 0	0 7 0

BOMBAY, BARODA AND CENTRAL INDIA RAILWAY.

LOCAL RATE ADVICE NO. 14.

GENERAL.

Rates for milk and return empty cans by passenger trains.

Paragraph 2 of Local Rate Advice No. 75 of 23rd December 1913. On and from the 15th April 1914, the following will be the rates for the carriage of milk in galvanized *iron or zinc cans only* and return empty cans by passenger trains over the Bombay, Baroda and Central India Railway at owner's risk :—

	Rate per maund for milk in cans	Rate per maund for return empty cans
	Rs. A. P.	Rs. A. P.
Not exceeding 25 miles	0 2 0	0 2 0
Exceeding 25 miles but not exceeding 50 miles	0 3 0	0 2 0
Exceeding 50 miles but not exceeding 75 miles	0 4 0	0 2 0
Exceeding 75 miles but not exceeding 100 miles	0 5 0	0 2 0
Exceeding 100 miles but not exceeding 150 miles	0 6 0	0 3 0
Exceeding 150 miles but not exceeding 200 miles	0 7 0	0 4 0
Exceeding 201 miles but not exceeding 250 miles	0 8 0	0 5 0
Exceeding 251 miles but not exceeding 300 miles	0 9 0	0 6 0
Exceeding 301 miles but not exceeding 350 miles	0 10 0	0 7 0

The above rates do not apply to cream.

FREDERICK W. HANSON,
General Traffic Manager.

(7)

MADRAS.

(D. T. CHADWICK, I.C.S., *Director of Agriculture, Madras.*)

Mr. Sampson's report on cattle in Madras which he prepared three and a half years ago has been placed before the Board of Agriculture.

I will only mention very briefly here the action that has been taken upon this, some of the difficulties which have been experienced in the past in regard to district work with cattle, some points on which we should very much like to hear the experience of other Presidencies and Provinces and the lines upon which it is proposed to make fresh efforts.

Important Breeds of Cattle in Madras. There are two very important indigenous breeds still extant in Madras *viz.*, the Ongole or Nellore bred chiefly in the adjoining portions of Guntur and Nellore districts and Kangyam bred in south-east part of Coimbatore. Both tracts are among the driest in the Presidency. It is worthy of note that in neither are there large forest areas where grazing is plentiful and cheap. In the Kangyam country the ryots set apart portions of their land definitely for grazing, stock is not allowed in them whilst the grass is young, and the fields are resown periodically with the chief fodder grass *Pennisetum cenchroides.* There is very little communal grazing. This system of fenced pasture land is however restricted to this tract. In the Ongole country most of the cattle are stall fed for a great part of the year. Common grazing in scrub and forests is more usual but in some villages these pasture grounds have been for a long time under a fairly efficient system of village management. Except in parts of Salem and North Coimbatore it may generally be said that the cattle in the vicinity of Government forests where low rates have been charged for grazing are poor.

Need for Government Breeding Farms.

Tradition has it that there were other distinctive breeds in Madras. They certainly can hardly be found now. There are distinct evidences that the purity of the Kangyam breed is now being threatened and in Ongole some report a tendency on the part of the ryots to forsake cattle breeding for arable farming. The evidence on this point is conflicting and is not borne out by statistics. Connected with cattle breeding is the question of fodder. The importance to the presidency of this question of cattle is realized and the sanction of the Secretary of State has been obtained to the appointment of a Deputy Director who can give all his time and attention to cattle breeding and cognate subjects. It is proposed to start farms first on the edge or in the Ongole and Kangyam tracts where our most suitable breeds are found.

Experience with placing breeding bulls out in the District. In the past this has been mostly in the hands of the Civil Veterinary Department and Mr. Ware can speak to the facts with more first hand knowledge than I can.

(*a*) Bulls have been given or bought for some of the District Agricultural Associations. Most of these have been neglected, very few have done good work.

(*b*) They have been given to a village and placed in charge of a leading ryot. These also have been neglected and in a few months become useless.

(*c*) When no ryot has undertaken the responsibility they have been placed in charge of the Village Headman and he has been paid 8—12 annas a month for their upkeep. This has been a little better but not much.

(*d*) They have been placed at Veterinary Hospitals. Here they have been properly looked after but have had no effect on breeding. These hospitals are in towns and it is dairymen who bring most cows to these bulls. These men very often care nothing for the resulting calf. They only look to the cow's milk for sale.

(*e*) Many of the Ongole bulls even when looked after properly and exercised not infrequently show at an early age an extraordinary loss of sexual appetite and are bad servers.

Against all these has to be put the fact that we have had to increase the number of bulls at stud at the Central Farm Coimbatore. Although the fees for service have been steadily raised from nothing to 12 annas, the ryots' cows served have also increased and last year numbered over 500.

Proposals. (1) It is proposed to keep bulls for service for fee at those of our district farms where there appears to be a demand.

(2.) To distribute bulls not generally throughout the Presidency but firstly more in the neighbourhood of our breeding farms.

(3.) Every effort will be made to sell them either to a leading ryot who will make them available to his other villagers, or to a Village Society. And it is hoped that the Government will agree to a scheme whereby these bulls shall be inspected annually and if they have been kept in good condition throughout the year and a record of work done by them kept (this last will be difficult to check) will pay to the person or society who looks after the bulls a sum equal to the whole or part of the past year's maintenance charges. This is on the lines of the Bull Breeding Societies organized by the Board of Agriculture, England. Another class of society who it is hoped will take them are the Forest Panchayats in the villages (*vide* below).

We should be glad to hear the degree of success which in other Provinces has attended the different methods of placing out breeding bulls.

Pasturage. Some landholders with large waste lands reserve them for pasturage, allowing in ryots' cattle usually at four times the rate charged in Government forests. They are not allowed in when the grass is just sprouting and not infrequently the ryots are forbidden to remove the cattle droppings. On a very small scale in some of the more intensely cultivated tracts (*e.g.*, Kistna delta) some ryots set aside small portions of their own land for the grazing of their own cattle. An officer of the Agricultural Department is now out in the Ongole country collecting specimens and information about the fodder grasses most held in repute by local graziers. Three such are being tested at Hagari Agricultural Station. Imported fodders have been tried to some extent at Coimbatore including silver beet, Teff grass (I think variety Tseddia but am not sure). Guinea grass is far and away the best so far. Both of these lines of enquiry will be pushed on, especially when we get our breeding stations.

Forest Panchayats. As a result of an enquiry into Forest Administration conducted a few years ago the Madras Government has decided to disafforest many of the smaller and more local forests and hand them over on payment of a certain rent and under certain conditions to a panchayat formed in the villages in which the forest is situated. In some cases the main object to be served is grazing. It is admittedly an experiment and some may succeed; some fail. Those that succeed should form good agencies for taking over breeding bulls. They are now being made. My only regret is that the Agricultural Department had not 15 to 20 years experience behind it in the matters of breeding and control of pastures to place at the disposal of these young societies. It is the chance of a century. It is hoped that we may not yet be *too late*.

Shows. It cannot be said that cattle shows grafted upon existing cattle fairs have so far done much to foster good breeding. Two districts are persevering with them. Many other cattle shows were still more artificial, cattle being specially bought for the glory of the show. Most of these have died down. The Ongole show has on the other hand created a market or fair, but the show is mostly financed by the Local Boards and Government. If the spirit of emulation in cattle breeding exists and can be fostered by shows it is felt that they must be much more informal village ones. It is necessary to get down to the village. One large zamindar has been promised assistance and asked if he will have such competitions in some of his villages among the village cattle where every one knows which are locally bred and which are recently bought. Then for a circle of villages there will be competition among the village prize winners. We wish him to start this and continue it annually for some years. The issue at present is in the balance.

Dairying. There is an increasing demand in the neighbourhood of the larger towns for breeding bulls of dairying strain. In Madras city the increase in the number of cows and cattle possessing a strain of Australian blood is extraordinary and very noticeable. Attempts at evolving a dairy strain are in progress at Coimbatore but more is needed.

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(8)

CENTRAL PROVINCES.

(a)

Note on Preservation of Grazing Grounds in Forest Areas.

(D. Clouston, M.A., B.Sc., *Deputy Director of Agriculture, Central Provinces.*)

The areas of waste land and Government forest open to grazing in the Central Provinces are very large. Cattle-owners are thereby encouraged to keep large herds of cattle which are in fair condition from August till December, but which in many cases suffer from partial starvation for the rest of the year. The fault of the owner is that he relies so much on the large grazing area at his disposal that he fails to make adequate provision for the food of his stock in the dry season when grazing is very scanty. Until stall-feeding can be introduced as a general practice therefore, the throwing open of larger areas of forest land for grazing will only tend to intensify this practice of extensive slipshod cattle rearing. Very few cultivators make a practice of storing grass for fodder even in tracts where it is offered for that purpose free of cost. The whole attitude of the cattle-owner towards breeding is radically wrong. He neglects to select his animals; he neglects to feed them properly, and he neglects to house them comfortably. He has yet to learn to appreciate the value of good stock, and the great scope there is for improvement.

I am strongly of opinion that cattle-breeding should be taken up seriously by Government. No branch of husbandry is so absolutely neglected by landholders in these provinces: and on no branch of husbandry is all-round progress in agriculture so dependent. The Department has already made a good beginning in Chhattisgarh. The soil of much of the extensive grazing grounds of this Division is *bhata* and *bhata-matasi*, names applied to poor gravely soil which produce poor crops of *kodo* and inferior grasses, of which *sukla* or spear-grass (*Andropogon contortus*) is the predominant species. Six years ago I carried out experiments to ascertain (1) whether it was possible to substitute a better grass for *sukla*, (2) to ascertain whether there was any advantage gained in cutting it early and (3) to find out by practical experiment what the nutritive value of the grass was. *Mushel* (*Iseilema laxum*), *Kel* (*Andropogon pertusus*), *Marvel* (*A. caricosus*) and others were sown in cultivated and manured *bhata* soil from which all the spear-grass had had been eradicated. The better grasses failed to stand the hot weather, however, and the hardier spear-grass, which is well adapted to the xerophilous conditions of a *bhata* plain, again established itself. By cutting speargrass before the spears had had time to form, *i.e.*, before the middle of November, it was found that the value of the hay as a fodder was greatly increased. Cattle ate it readily though they refused to taste that which had been cut after the spears had developed. The experiment to test the nutritive value of spear-grass was carried out with 10 young animals which were purchased as year-olds and got no food but *sukla* grass for three years. They were grazed on *sukla* pasture during the day and stall-fed on *sukla* hay and silage in the evening. After three years they were found to be 9 inches more in girth than village cattle of the same age.

On the strength of these results two co-operative cattle breeding farms and one Government cattle-breeding farm have since been opened on similar land in Chhattisgarh. Several more will be opened on Government fodder reserves as soon as good stock can be obtained for them. These Government fodder reserves have failed to fulfil the purpose for which they were reserved, *viz.*, as areas from which neighbouring cultivators could get supplies of grass or fodder. In the absence of any such demand the grass was used purely for thatching purposes.

A cattle breeding farm is to be opened shortly in a forest area on Raigarh plateau with a view to encourage breeding in this tract which is a recognized grazing area and where grazing is plentiful and the conditions otherwise suitable for stock rearing. Any question as to the increase or improvement of grazing areas is not nearly so important in these provinces at least, where the limiting factor as far as grass production is concerned is the rainfall, as is the larger question of breeding and feeding on right lines. Much can be done, however, to improve grazing areas by planting trees where there is too little shade, by bunding up streams so as to keep the grass green on their banks throughout the cold and hot weather, and by constructing small bunds along contour lines to hold up the silt where much scouring goes on.

The number of cattle breeding farms in these provinces is being increased as far as circumstances will allow. There is much scope for private enterprise as well as for co-operative societies of breeders. Should the two co-operative breeding societies started by the Department in Chhattisgarh prove successful many more will be started on the same lines. Breeding farms have already been opened by Government for the improvement of the four principal breeds of the provinces. With our present staff it is doubtful whether it would be wise to go ahead any faster than we are doing. Much better progress could be made if a fully qualified cattle breeding expert were appointed for the province who could be put in charge of all the breeding and feeding experiments. The work requires specially trained men who have had experience at Home.

The breeding of good dairy stock, though of enormous importance, is entirely neglected at present. This occupation is in the hands of the *gaolies* whose methods of breeding and feeding are of the most primitive kind. It will be very difficult to start dairy enterprises with any hope of success till something is done to increase the supply of good dairy stock by careful breeding. No milk records are kept and no effort is made by these illiterate breeders to select for breeding cows and bulls of the best milch strains. To remedy this state of matters a breeding farm for dairy stock has been opened at Telinkheri. Fine Delhi milch buffaloes are being bred, and crosses are being produced between the Delhi and the local breed. Experiments are also being carried out in crossing Gaolao cows with bulls of the Montgomery and of the Ayrshire breed.

As the rearing of young dairy stock near Nagpur is expensive owing to the limited amount of grazing available, it is proposed to send the young stock from the Dairy Farm to the Raigarh Cattle Breeding Farm to be opened shortly. The breeding of pure Delhi buffaloes and of Delhi-Nagpur crosses will also be carried out there.

As an adjunct to the Telinkheri breeding farm for dairy animals, a Gaolies' Society has been formed. The Society has nearly 200 milch buffaloes and cows which are kept with the Government herd and which are crossed by our Government bulls. This is an honest endeavour to show our professional milkmen how to improve their lot.

The arrangement in these provinces by which bulls are sold to those who are willing to pay most for them works well. Bulls used to be given out on loan by our Department, but the system proved a complete failure. Those to whom they were given regarded them as being of little value, seeing that they had nothing to pay for them, and the result was that they were neglected to such an extent that they became emaciated and failed to do their duty.

The ordinary cattle show does not serve a useful purpose, and never will until there is some closer connection between breeding and shows. Prizes for cattle can only have a good effect when the recipients earn them as the result of continuous effort to improve their stock. In Chhattisgarh a silver cup is now offered at the Raipur cattle show for the best group of 12 cows and one bull exhibited by any private breeder or society of breeders. Our aim is to get a large number of breeding farms established and to create a healthy rivalry among them with a definite aim in view. The large number of mongrel immature bulls which are to be found in every village herd are serious handicaps to organized attempts at cattle-breeding on scientific lines. So long as such bulls are allowed to graze in a village it will always be difficult to prevent the good cows kept for breeding being covered by them. But when once cattle-breeding is taken up by the land-holders themselves this difficulty will disappear, as such bulls will be castrated when young. Early castration is in no way detrimental as far as the resultant bullock is concerned. It improves his temper and makes him more active in his movements. Religious prejudices will melt away as soon as the advantages gained become evident.

I have for the last six years given the fodder question a great deal of attention on the Telinkheri, Nawagaon and Akola farms. The experiments with *sukla* grass on the Nawagaon Reserve have already been referred to. In this experiment the nutritive value of hay made by cutting *sukla* grass before the spears formed and by drying it in "cocks" was demonstrated in a very practical way. Surrounding Malguzars were afterwards induced to purchase some of this hay for their cattle. On the strength of the results obtained the Deputy Commissioners of Drug, Raipur and Bilaspur are working on the same lines in demonstrating the feeding value of well made *sukla* hay on some of the Government fodder reserves. Experiments have also been made to ascertain the best depth of pit silo for *bhata* soil. Silage of *sukla* grass made in pit silos was freely used in the Nawagaon feeding experiment.

A great variety of crops likely to prove useful as green fodders have been tried. The most promising of these are clover, sann hemp, *juar*, maize, wild lucerne (*Melilotus alba*), Rhodes grass (*Chloris gayana*), and Guinea grass; but many other species obtained from all parts of the world have been tried. Of these clover is by far the most valuable. It was tried by me for the first time in these provinces six years ago; it is now being grown on every Government Farm where irrigation is available. On the Telinkheri Farm alone there are 15 acres under this fodder at present. Sann hemp by itself and as a mixture with *juar* or maize is a useful fodder for the hot weather and is being grown extensively for that purpose on the Telinkheri Farm. Three of the best grasses, namely, *mushel*, *marvel* and *paonia* (*Setaria glaucus*) have been tried as green fodders under irrigation, but it was found that grass, though irrigated, makes little growth in this climate after the rains have ceased. Guinea grass does much better in the hot weather than our indigenous species, especially when given a little shade; but it too falls far short of clover followed by *sann* mixed with *juar* or maize.

All the edible cakes are being used as concentrated foods in large quantities on the Government Farms in my Circle. Consignments have been obtained during the present year from 7 different mills. Cotton hulls obtained from Bombay have also been utilized for feeding. For the last two years we have used a large quantity of rice husk for mixing with more concentrated food stuffs.

It should be possible to get cultivators in villages commanded by irrigation to grow one or more of the fodder crops mentioned above, as soon as cattle breeding is properly organized. For the present it would be very hard to make them believe that the end in view would justify the trouble that would be necessary. If, however, enterprising land-owners can be induced to lead the way by starting breeding farms and to adopt economical improvements in their system of cropping in order to raise more fodder, others will follow their example.

Very few cultivators rely on forest areas for a supply of fodder. Such areas are often at a considerable distance from the villages. Many of the grasses too are inferior in quality, and are still more so when cut after they are dead ripe. October, November and December are three busy months for the cultivators all over the provinces. In the rice tract he is harvesting the crop during that time; in the wheat tract he is sowing his *rabi*; while in the cotton tract he is picking his cotton, sowing his *rabi* and harvesting his *juar*. The result is that nearly all the grass taken from the forest is cut after December by which time it is rank and coarse. Cultivators could provide against famine years by storing surplus grass and *karbi* in good years. An experiment carried out on the Akola Farm showed that of a large stock of *karbi* kept for a year without cover of any kind only about 10 per cent was damaged. Hay stacks have been kept standing on the Telinkheri Farm for a year without being damaged even to that extent. But

stack building is an art in which proficiency is not easily acquired by the average Indian cooly. I have found it possible, however, to get stacks fairly well built by insisting on the use of a bamboo frame work and on certain specific rules of construction being followed.

Experiments with prickly pear were tried on Nagpur Farm some years ago by R. B. Joshi, Assistant Director of Agriculture. The results were much less promising than those since reported on from Poona; but in any case it is pretty certain that prickly pear would only be thought of as a cattle food in famine times, and that with the large areas of forest land at our disposal in the Central Provinces prickly pear is never likely to play an important part in famine times.

The nutritive values of different cakes have been compared *inter se* and with cotton seed. Undecorticated cotton cake was found to be one of the cheapest cattle foods on the market. *Mahua* refuse from the distillery was also tried but found to be of little feeding value.

(b)

Letter No. 1253, dated Jubbulpore, the 22nd April 1915, from G. Evans, Esq., M.A., Deputy Director of Agriculture Northern Circle, Jubbulpore, to the Director of Agriculture and Industries, Central Provinces, Nagpur.

With reference to your letter No. 4, dated the 7th April 1915, I have the honour to state that no definite and systematic feeding tests on cattle have been attempted on either of the Experimental Farms in my Circle as to be of any scientific value, such tests would have to be carried out in close collaboration with the Agricultural Chemist.

I will refer to the different points you mention in your letter to the Secretary to the Hon'ble the Chief Commissioner in detail so far as they apply to my Circle.

1. *Preservation of grazing grounds in forest areas.* In parts of Hoshangabad and Narsingpur there have been complaints from time to time of the shutting down of Government forest to grazing. On enquiries being made, however, it is nearly always found that the Forest Department have closed certain forests on the borders of the great cultivated tract of the Nerbudda valley, but have opened others farther in the hills. As you are probably aware owing to the lack of grazing land in villages in the wheat tracts of the Nerbudda valley cultivators always send their surplus stock away to the hills to graze in the rains. This complaint, therefore, resolves itself into the inconvenience caused by the further distance they have to send their cattle before they get to the grazing blocks. On the other hand, there is no doubt that the accessible jungles were no doubt annually very much over-grazed and some action was necessary to avoid serious damage to regeneration of forest growth.

2. *Improvement of waste areas.* In villages near the jungles, large areas of waste occur but partly owing to the poor nature of soil and mainly, I think, on account of the ravages of wild pig, Nilgai, etc., it is not as yet profitable to cultivate these lands, and they serve as grazing areas and fuel reserves for the neighbouring plain's villages. In the latter villages very little waste areas occur with the exception of encamping grounds and lands reserved for threshing floors. Borders of streams and *nullahs* are left under grass and wood partly to stop scouring and partly to provide exercising and grazing lands for the village plough cattle and buffaloes.

In the Jubbulpore Haveli it is now becoming quite a common practice to bund up *nullahs* every September to ensure a supply of drinking water for the cattle and occasionally also such *nullahs* are used for irrigation purposes.

3. *Increase in the number of cattle breeding stations.* In the Northern Circle one station occurs at Powarkhera near Hoshangabad. The herd was started nine years ago and was formed from selected cows and bulls purchased at odd places in the Central Indian States. The breed is Malvi. Pure animals of this breed are extremely hard to obtain and, as a matter of fact, we have found that many of what were apparently our best and purest stock, have given progeny of inferior nature which shows that they have outside blood in their pedigree. We are now practically confining ourselves to breeding from the descendants of three of the original cows, and in-breeding between these three families is now taking place.

We are thus building up a pedigree, and the results are so satisfactory that the young bulls are able to command nearly double the price we did for them three years ago.

The area for grazing is about 220 acres, and the size of the herd about 125, which is about all this area can carry. The demand for bulls is very keen, and we have about 25 applications for the four or five bulls we turn out every year. These bulls are only sold to malguzars and others who promise to start cattle breeding on certain broad lines laid down by myself. The demand is specially keen from the Jubbulpore Division, and it is rather a hardship on certain intending purchasers who have to pay Rs. 150 for the bull and in addition a further Rs. 30 or Rs. 40 in railway and additional charges before the bull reaches its destination. Apart from this we shall have to introduce a fresh strain of blood into the Powarkhera herd in two or three years' time as we cannot go on inbreeding for ever without impairing the constitution of the cattle.

Since we cannot very well increase the area of Powarkhera farm and the number of bulls turned out annually (six) is so small, I think we have a good case for starting another herd of pure Malvi cattle as this breed is in universal demand in all the heavy wheat-growing villages.

My own idea is that we should start such a herd near Jubbulpore and, I believe, we should have little difficulty in securing the necessary grazing area within a few miles of Jubbulpore along the Kundam road.

Other minor breeds occur, and we shall have to tackle before very long the question of providing a really good breed of light cattle for the shallow soils and stony uplands of the Satpura districts. Several breeds occur such as the Ramgarh in Mandla and the Kanhan in Chhindwara and the red and black Gondi breed in various places. All are, however, very much interbred and mixed, but I believe that out of the Gondi cattle we could by careful selection raise an extremely useful type of animal for light work. The natural grazing grounds for these cattle are the Jagirs of Chhindwara and all along the jungles on the Northern face of the Satpuras.

4. *Maintenance of indigenous breeds of value.* Some of these breeds have been mentioned in the above paragraph. The Malvi is the most important throughout the Nerbudda valley, and its place in the Vindhyans is taken by the Sankha breed which closely resembles it and is in fact another type of Malvi.

Cattle showing distinct traces of Gaolao blood occur in the south of Seoni District but our experience with this breed shows that it is unsuitable either for upland work or for the heavy draught of the wheat plains.

5. *Breeding tracts.* Large areas occur of which perhaps the Chhindwara Jagirs offer the best scope. Grazing and water is abundant, much of the land is unsuitable for cultivation, and the demand from Chhindwara on the one side and the Nerbudda wheat plains on the other is inexhaustible, while prices are extremely good.

6. *Distribution of stock from the Government Farms.* Bulls are only issued to persons who agree to open cattle breeding farms on lines drawn up by the Deputy Director of Agriculture. Four such farms have been started in the Nerbudda Division and seven in the Jubbulpore Division.

The best of the local cows are kept to run with the bull and the breeding herd is kept entirely separate from other cattle. The object in view is not to breed stud bulls, as this cannot be done, none of the cows locally obtainable being pure bred and we know also nothing of their pedigree.

All young male stock therefore are castrated and fresh pedigree bull is obtained from the Government Farm when the original bull is finished. In this way it is hoped after two or three generations to build up a good grade herd of cows showing marked Malvi characteristics.

I have long ago come to the conclusion that a malguzar does not at present see any money in raising pedigree stock, but he knows very well the value of a really good bullock, which fact is continually being impressed on him by the yearly increasing price of good plough bullocks. If we can convince him that he can by following definite simple rules of breeding, feeding, etc., raise just as good bullocks as he can buy and at a far less cost, then we may get him to begin to understand the meaning and value of pedigree.

It is useless to expect improvement by simply introducing good bulls, as, if the owner does not feed his cows properly, the young stock will remain poor and will show little signs of improvement.

7. *Cattle Shows.* Fairly keen competition for prizes is seen at the Garhakota fair, but it is noteworthy that practically all the best cattle come from outside the Saugor District from the Central Indian States. Prizes are also given at the Jubbulpore Divisional show and at one or two of the smaller district shows, but little success has been achieved yet in attracting good local cattle in spite of the fact that the prizes offered are considerable.

Owners are reluctant to bring valuable cattle, often for a long distance, into a show as they do not know what facilities exist for housing and feeding their exhibits, and there is also the danger of an epidemic of some infectious disease.

8. *Elimination of undesirable male stock.* Sound in theory but difficult to apply in practice. Also Government must be in a position to supply a much larger number of pedigree bulls.

9. *Increase of staff.* More staff is urgently required for the inspection of private cattle-breeding farms as well as for the establishment of new Government Farms.

(C)

Food and Fodder Supply.

(G. Evans, M.A., *Deputy Director of Agriculture, Central Provinces.*)

In this note I propose to mention briefly what action has been taken on the recommendations made by Committee V at the meeting of the Indian Board of Agriculture, held in December 1913, at Coimbatore. The different heads will be discussed separately, but in every case action has not been possible owing to the paucity of staff.

(1) *Existing sources of fodder.*

Owing to the large area under jungle in this Circle, grass is on the whole abundant, especially in the rains and cold weather. The jungles occur in big blocks, however, and certain large open cultivated areas feel the lack of grazing acutely in the first six months of the year. This refers particularly to the Nerbudda Valley proper from which tract all non-working cattle are sent annually to "Gwari" for the rainy season, grazing from the middle of July to November. Much of the available grazing is in Government jungle, and the recent enhancement in grazing rates has caused a certain amount of discontent.

The enhanced rates, however, still continue to be extremely reasonable, and grumbling is, I think, more often caused by the fact that grazing has been restricted in certain forests bordering on the cultivated areas, which were formerly heavily over-grazed, and as a consequence cultivators now have the trouble and inconvenience of sending their cattle further into the remoter depths of the jungle.

The common grass of the Central Provinces jungles consists of spear grass (*Andropogon contortus*) but small areas also exist of better grasses such as Kel (*Andropogon annulatus*), Muchhel (*Iseilema Wightii*) and Ponia. The supply of these grasses is, however, limited, and wherever grass *birs* of any size occur, as they do near Jubbulpore, they are usually leased out or reserved for hay.

In Hoshangabad and Narsinghpur districts most plain villages possess a certain amount of grass *birs* of good quality on the edges of *nullah* and on broken land which is hardly good enough for cultivation. These are always reserved for grass, and the hay from them is always reserved for feeding the working bullocks and milch buffaloes. It is rarely sufficient to last longer than March, when the cultivator relies on the *bhoosa* from his wheat crop to eke out supplies until the rains.

Grass so made into hay is generally cut far too late. Spear grass, for example, is not usually cut until December when the spears are hard, and at this stage it is practically useless for fodder. In co-operation with the Forest Department large quantities of this grass were cut and baled and were carted to one or two large centres in the middle of the Jubbulpore Haveli. This area is particularly short of grazing. Although the baled grass was offered at rates considerably cheaper than local grass, practically none was sold as the quality was so poor.

A feeding experiment was carried out at Adhartal with this grass, but after a fortnight the bullocks fed with spear grass so fell away in condition that the experiment had to be stopped.

Spear grass cut in October has been largely experimented with at Pachmarhi with good results. It is never a grass of first rate quality, but if cut before the spears begin to harden it is at any rate palatable and is readily eaten by cattle and even by horses.

In October, however, labour is fully occupied elsewhere in sowing *rabi* crops and harvesting cotton and other *kharif* crops and is not obtainable for grass cutting until after the middle of November. Good results have been obtained by the Nerbudda reaper to which a special grass cutting attachment has now been fitted, and special training classes in the use of this machine and in proper hay making methods are held on the Government Farms at Adhartal and Powarkhera.

A limited number of enlightened malguzars are beginnir to take up the use of this ma hine. Its use is, however, bound to be limited as most of the grass *birs* consist of uneven ground full of rocks, stumps and bushes in which it would be impossible to use the machine. In this connection it may be stated that a set of experiments have been laid down at Adhartal with a view to ascertain the best way of improving spear grass meadows and at Powarkhera a manurial series has been going on for several years past with the result that Ammonium Sulphate plus Superphosphate has always given a largely increased yield of hay per care. These experiments are still in their initial stage, however.

Jowar (*Andropogon Sorghum*) stalks form a valuable fodder, a fact which is not yet fully recognized locally. In most cases only the tops of the stalks are cut off and and the remaining five feet are left standing. The recent failures of the wheat crop and consequent shortage of *bhoosa* have, however, given some of the better class of cultivators cause to think, and a distinct movement in the use of fodder cutters for dealing with the whole of the *jowar karbi* has been noticeable in parts of Hoshangabad in particular.

Besides the above, the common fodders are pulses, particularly gram and *leora*, cotton seed and cakes. These concentrated foods are as a rule only fed to milch buffaloes and to bullocks at times of hard work. The value of machine-pressed oil cakes is not yet appreciated as small oil pressing mills opened at Itarsi and Saugor have both failed to make progress, the only cakes they have disposed of being for manurial purposes. *Teli's* cake is preferred as it is softer and contains more oil.

Ensilage is made on the Government Farms, but is only rarely attempted by private individuals. Good ensilage has been made out of chopped green *jowar* and coarse grasses such as Kans (*Saccharum spontaneum*). Ensilage would chiefly be wanted in the cultivated areas, but the deep black soils render pits impossible and the cost of silo buildings is too high to tempt any cultivators to invest their capital in them.

(2) *Fodder crops in rotation.*

In certain thickly cultivated parts this necessary practice is already beginning to be understood. In the Jubbulpore Haveli a relatively large area of *teora* (*Lathyrus sativus*) is sown either pure or as a mixture, and it is often cut green and stall-fed to cattle. In this district also a demand has recently sprung up for fodder *jowars*, and a good deal of seed is imported from Gujarat. Ringni *jowar* is also being being tested on a considerable scale in the Haveli proper, where, owing to the heavy nature of the soil, *kharif jowar* cannot always be grown.

(3) *Stall-feeding.*

Mention has already been made of the attempts to introduce baled grass for stall-feeding purposes. As a rule the cultivator only stall-feeds his buffalo, cows and plough cattle, and he gives them what is locally available. The working bullocks are stall-fed with dry grass in the first three month of the year supplemented with rice or *kodo* straw. In March these sources fail, and *bhoosa* from the *rabi* crops keeps them going until the rains set in. At seasons of hard work, such as the sowing period, a good cultivator will supplement his bullocks' ration with a pound of cotton seed, *teora* or some other cheaply available grain.

As mentioned above there is a distinct prejudice against mill-pressed oil cake, and action will have to be taken to popularize its use.

(4) *Storage against famine.*

A fodder reserve of half the average quantity of grass annually consumed is kept up on the Government Cattle Farm at Powarkhera. This grass is always kept in Dutch Barns. An experiment in stacking grass, thatched with rough grass, throughout the rains was made, but owing to the heavy rain and partly no doubt also to inexperienced thatching, there was a good deal of grass spoilt. Experiments are being continued. The danger of a cattle famine is not so acute as in other provinces owing to the large amount of Government jungle available for grazing in case of a scarcity.

Prickly pear is not available in any quantity, being chiefly planted as a hedge round small gardens on the outskirts of villages.

(5) *The relative food values of Indian cattle foods.*

Owing to lack of necessary staff and equipment it has not been found possible to do any work in this direction.

(d)

Note on cattle-breeding.

(J. H. Ritchie, M.A., B.Sc., *Deputy Director of Agriculture, Central Provinces.*)

(1) *Preservation of grazing grounds in forest areas.* The question of grazing areas is of minor importance in Berar, where the cultivators grow considerable areas of *juar* for feeding to their bullocks. The general standard of the Berar bullock is far superior to that of the Central Provinces. The Berar cultivator takes great pride in the appearance and the welfare of his cattle, and the prices of good bullocks of any of the indigenous breeds are consequently very high.

This attention and care is mostly bestowed on the bullocks, however, while the cows are left more or less to their own resources. They are allowed to pick up whatever they can find on the border of fields and in the village grazing areas. This is usually supplemented by a quantity of *karbi*. Little or no cotton seed is fed to them. Indian cultivators have yet to learn that a cow bringing up a calf is expending as much energy as a bullock doing medium road work.

When I speak of the Beraresе not devoting the same care to their cows as they do to their bullocks, I do not mean to infer that the cows are neglected, emaciated and starved. Far from it. They are totally different from those generally to be met with in Chhattisgarh and in the Jubbulpore Division. They are, as a rule, fairly plump, but a little more attention might result in a bigger-boned off-spring.

Coming back to the question under discussion, we may take the case of Borgaon. This area consists of about 1,400 acres of grass reserve, out of which the Agriculture Department has recently taken over 360 acres to start a breeding farm. The area is stocked by a good crop of the following useful grasses :—Pohna (*Ischæmum sulcatum*) ; Shewda (*Ischæmum laxum*) ; Kunda (*Ischæmum pilosum*) ; Mushel (*Iseilema Wightii*), while there are small areas of Tikari (*Andropogon schœnanthus*), Kusali (*Andropogon contortus*) and Kunda (*Ischæmum pilosum*).

The chief work to be carried out at this place is the breeding of good animals of the Khamgaon breed, which is the best of the indigenous breeds of Berar. In addition to this, feeding experiments will be carried out with different food stuffs to find out their relative values and the most economic combinations. Manurial experiments on grass will also be attempted, and the eradication of the above-mentioned coarse grasses which are of no value for fodder purposes.

(2) *Improvement of waste areas.* Something has already been said on this point under the last head, *viz.*, the eradication of useless grasses unsuitable for fodder.

The cattle-breeding farm at Borgaon is entirely dependent on a small well built by the Forest Department. A small *nullah* runs through a part of the area belonging to the Department, but this dries up towards the end of the cold weather. Something, however, could be done to " bund " this up so that the well water be economised. It will also help to give us a larger supply of green fodder along the banks of the *nullah*.

Nothing has been done, as far as I am aware, to improve waste areas in this Circle, though, by adopting the methods suggested in your letter, considerable areas could be made to give longer grazing periods than they at present do.

(3) *Increase in the number of cattle-breeding stations.* Requires no comment.

(4) *Maintenance of indigenous breeds of value.* As mentioned above the breeding of the Khamgaon breed of cattle is being carried out on the Borgaon Cattle-Breeding Farm.

In addition to this a co-operative breeding society will be started next year in Nimar to improve, or better to preserve the Nimari breed of cattle which is fast becoming extinct. This society would have been started in 1914, had not the war affected the pockets of the promotors. The site for this co-operative cattle-breeding society has

been selected in malguzari land some 3 miles from Chandni Railway Station in Burhanpur Tahsil. The Nimari breed of cattle is not suited to heavy draught work such as is required in agricultural operations.

A more profitable animal to deal with would be the Khargaon, many of which are to be found in Nimar. They are indigenous to Indore and are bred on the north side of the Nerbudda river. It might be possible to get a society started to deal with this breed for they are far superior to the Nimari breed for slow heavy work. A judicious cross between a Khargaon bull and a Nimari cow would greatly improve the appearance, size and physique of the latter animal.

(5) *Breeding tracts.* Requires no comment.

(6) *Distribution of stock from Government Farms.* Requires no comment.

(7) *Cattle Shows.* A certain amount of improvement will take place by getting the cultivators to exhibit their animals, but no real benefits will be apparent till private breeding is taken up by a large number of persons. The first step in this direction was to be seen at the Raipur Cattle Show last year where a silver cup was presented to the best group of cows and bull belonging to any of the breeding societies.

At many of these fairs where prizes are given for the best pairs of plough bullocks, a person who gets a prize invariably increases the sale price of his cattle. This is quite a good spirit and is a good step forward towards improvement.

On the other hand, many people look on these cattle shows at fairs as a sort of menagerie and become quite indignant when they are refused a prize for a gaudily dressed goat or a cow with some abnormal deformity.

One very interesting feature of the cattle show held at the Pimpalgaon Devi Fair in the Buldana District this year was the fact that one cultivator carried off most of the prizes (60 per cent). This cultivator has always taken a great interest in cattle rearing and his herd, which I saw later in his village near Khamgaon, is really an excellent one. Out of the many and varied colours of the Khamgaon breed, he has hit on a particular spotted type, and the markings are identical in all his animals. Were we to find several men like this one, the importance of cattle shows would be greatly increased.

(8) *Elimination of undesirable male stocks.* The custom of dedicating bulls to the God is one of the great drawbacks in the improvement of Indian stock. As a general rule bulls are not castrated till they are between 3 and 4 years old. People are under the impression that early castration prevents the animals from attaining their full growth. This is a false impression because the opposite is the case. In an early castrated bullock, the amount of substance that would go to develop the useless parts is utilized in a general development of the body. Flesh is put on more evenly all over the body. The animal becomes quite docile and tractable and is more easily broken to work.

On the Borgaon farm, we shall carry out experiments with early (6—12 months) and late (3 years) castration on bulls which are unsuitable for stud purposes.

(9) *Increase of staff.* Encouragement to start private breeding farms will be given by the Department when there is a bigger staff to supervise them. At present the areas to be covered by the Agricultural Assistants are enormous, and it is impossible for them to take up such a secondary work as cattle-breeding supervision along with their other more important duties.

(10) *Food and fodder supply.* This has been partly taken up under the first head, *viz.*, preservation of grazing grounds in forest areas. As already mentioned Berar is less dependent on grazing areas than the Central Provinces because of the system of cropping followed. The cultivator generally grows an acre or two of *juar*, which is sufficient to give him enough fodder for his bullocks for the year.

When the rains break and borders of fields produce their crop of grass the cattle are allowed to pick up all they can get. Also from January onwards they wander over the cotton fields grazing on the few remaining leaves of cotton left on the plants after picking is over. The amount of this fodder is sometimes considerable if late rains have been received. Such sources of fodder supply are however secondary, for the Berari depends on his *juar* crop as the staple food for himself and his bullocks.

Much has yet to be done in teaching them the best methods of economizing their fodder. The Department has recommended for years the use of the latest types of fodder cutters, and those who have tried them are loud in their praise. None of the *karbi* is wasted as was formerly the case, when whole stalks were fed to bullocks. We reckon that from ½ to ⅓rd the amount of *karbi* is required to supply the requisite feeding value to the bullock.

Better methods of storing would also give considerable savings. The cultivator ties his *juar* stalks into big bundles and builds them into a rough sort of stack, putting a few *babul* branches round the foot to keep off cattle. Nothing is put on top to run off the rain, which soaks into the interior and rots it. A fairly thick thatch of coarse grass would save large quantities of *karbi*.

In a cotton growing country like Berar, another cheap form of food for cattle is cotton seed, which along with *karbi* renders the people entirely independent of grass. It is usually fed whole to the cattle, a system which is very wasteful. The most economical method is to feed decorticated cotton cake. There are two firms in Berar employed in the oil cake business. One of them produces very good decorticated cotton cake and the other has recently taken up this form of product.

The people look with suspicion on the factory made cakes, thinking that they contain little oil, which they believe to be the most important feeding constituent. In many places they use the cake made by the local *Telis* in their *deshi ghanis*. Such cakes are certainly richer in oil, for the wooden country mill cannot express the same percentage of oil as a powerful hydraulic press. After a certain point however it is uneconomical to feed oil because it is not all utilized by the animal and is excreted. As a matter of fact, the oil could be dispensed with completely since it performs the same work in the animal body as carbohydrates. Oil is the most expensive part of the cake, and if it were possible to extract all the oil from the meal, the resulting cake would be in every way as nutritious and should be considerably cheaper.

From one ton of cotton seed the following weights of by-products are got :—

	lb.
Linters	30
Hulls	942
Decorticated cotton cake	820
Crude oil	313
Dirt, etc.	135
TOTAL	2,240

Hulls are a very valuable feeding stuff and have been proved to be in every way equal, if not superior, to *karbi*. In Bombay they fetch Rs. 20 a ton, but in Berar, where the demand has not developed as yet, they will fetch only Rs. 4 to Rs. 5. The mill-owners find it cheaper to use them as fuel for their furnaces—wanton destruction of a valuable food.

It could be possible to feed nothing but the by-products of cotton seed to cattle and keep them in the best of form. Were the Berar ryot fully instructed in the uses of decorticated cotton cake and hulls, he could sow all his land with cotton and be fully assured that his cattle would remain in as good condition as before if not better. Decorticated cotton cake gives to the animal a more even development. In cotton seed and undecorticated cotton

cake nearly 25 per cent of the contents is undigestible fibre, which in bulk tends to make the animal "pot-bellied." The stamina of such an animal is also much inferior to an animal fed on a concentrated food like decorticated cotton cake.

Other cakes and foods are seldom used in Berar, although linseed and *til* seed are crushed in the mills at Akola but only for export to Great Britain. I hope that the Department will be able to teach effectively the benefits to be derived by using these concentrated foods in preference to cotton seed, so that both the cultivators and the millowners may reap the benefits.

(e) (i)

(The Hon'ble Mr. H. A. Crump, C.S.I., I.C.S., *Financial Commissioner of the Central Provinces.*)

The Board of Agriculture in India at their meeting of the 8th December 1913, recorded their opinion that Government Cattle-breeding Farms in every province of India were too few and laid down certain general principles regarding the improvement of cattle, and in Mr. Kershaw's letter No. 10—61-2, dated the 4th May 1914, paragraph 4, it was requested that at the next meeting of the Board, officers deputed from the provinces should be prepared with notes on the various points mentioned. Up to date some attempts have been made to deal with the question of the improvement of agricultural cattle, but no definite scheme has been drawn up showing the lines on which progress should be made and the efforts hitherto made have been rather sporadic.

The first thing to aim at is therefore a definite scheme or programme to be worked up to gradually as funds permit, and the following instructions deal with the preparation of such a scheme.

2. *Scope of Government Cattle-Breeding Farms.* Government cannot hope by the establishment of cattle-breeding farms to produce sufficient cattle to make any appreciable effect on agriculture, and the breeding of cattle for agricultural and dairy purposes must be left to private enterprise. A Government breeding farm is therefore not intended to produce cattle on a commercial basis, but like experimental farms its object is to maintain strains of the best breeds, to ascertain which breeds are the best and to produce fresh types suited to the special needs of the tract it serves. In order to improve the herds maintained by private breeders two objects should be aimed at :—

(1) the removal of all inferior bulls by castration at young age,

(2) the provision of pedigree bulls to be issued from the Government farm to private breeders who are willing to work under supervision.

The Government farm will produce a certain number of heifers and bullocks. But the heifers will be required for many years to come, if not always, for the extension and maintenance of the herd of the farm, and the bullocks will generally be absorbed on experimental farms to fill vacancies in the Government herd. Some heifers that are not of true type or suited for breeding at the Government farms will be sold in the open market and will probably be better than the local cows, but the number available will not be so large as to make any appreciable effect on the breed of cattle in the tract, and for the improvement of cattle it will therefore be necessary to rely entirely on the pedigree bulls issued from the Government farm to private breeders.

3. *Cattle Survey of the Province.* A survey of the cattle of the Provinces was undertaken about the year 1902, and the results were published in the Survey of Cattle of the Provinces in 1910. This survey *is not complete,* and in the case of several breeds it is remarked that no information is available. Changes may also have occurred during the past five years and it is therefore desirable before any final conclusions regarding the scheme for cattle-breeding are formed, that this survey should be examined, and if it is correct that important breeds are omitted, that it should be completed and brought up to date. It is considered that it would probably be possible to do this by the end of the year. This survey will then give us the most important breeds of the cattle in the provinces and the purposes for which they are suitable. It will indicate the most important breeding centres for each breed, the markets where they are sold, and the areas where and the purposes for which they are employed. It will thus form the basis of the scheme for the future improvement of agricultural cattle.

4. *Preparation of a Scheme.* The cattle survey alluded to in the last paragraph will then enable the Director of Agriculture to divide the Province into divisions for each of which a special breed of cattle is usually employed, and to determine for each such division the type of animal required, and the scheme for the establishment of cattle-breeding farms would then be framed to deal with the needs of each of these divisions ; it would indicate the number of breeding farms required for each division and would select approximately the sites suitable for them.

In making a selection of sites the remarks in the Proceedings of the Board of Agriculture in India held at Coimbatore on the 8th December 1913 should be borne in mind ; it was then suggested in regard to the situation of cattle-breeding stations that it was desirable that these farms should be ordinarily located in breeding districts where there is likely to be a demand for bulls. The correctness of this proposition should be considered having regard to the local conditions of the Central Provinces, as it is possible that the establishment of a cattle-breeding station in a suitable area might lead to the introduction of private herds.

In the case of existing farms, it should be considered whether they are well situated or their removal to another area is desirable to fit the principles which are most desirable for the improvement of cattle of the provinces.

5. The scheme should then set out in detail as far as possible what a model Government breeding farm should be. It should state the area required, the buildings suitable, the number of animals which should form the initial herd and the staff for its management, and should give a rough estimate of the cost—recurring and non-recurring. In preparing the whole scheme financial considerations will not play any very important part, and though economy should be observed in the proposals, the financial effect of the whole may be disregarded. The scheme would then indicate the order of urgency in which the various tracts should be taken up, and this will enable the Director of Agriculture to work up the scheme as funds permit.

6. In regard to staff, two points should be considered : (1) whether cattle-breeding farms should be directly under the Deputy Directors of Agriculture, or directly under the Veterinary Superintendent, (2) the way in which the superior staff should be trained and of what class of men it should consist, *i.e.,* whether it should be a man holding a veterinary diploma with a post-graduate course in cattle-breeding, or an Agricultural Assistant aided by a veterinary Assistant in charge of the veterinary work of the herd, or an Agricultural Assistant with a post-graduate course in veterinary science.

7. *Improvement of Milch Cattle.* The breeding of buffaloes and cows is an important matter in certain parts of the Province where the *ghee* trade is large. This question has not been dealt with to any extent in the Cattle survey and it will probably be necessary to have special enquiries made before a scheme for the improvement of milch buffaloes and cows can be taken up. It will therefore be better if the scheme for the improvement of milch buffaloes and cows should be kept apart from that for the improvement of other agricultural cattle. In connection with the dairy farms it might also be considered whether it would be possible to provide areas where dry cattle might be grazed at less expense than at the dairy as an adjunct to dairy Farms at Nagpur and other places.

This might enable a larger number of animals in milk to be kept at the dairies.

(e) (ii)

(D. Clouston, M.A., B.Sc., *Deputy Director of Agriculture, Southern Circle, Central Provinces.*)

In the Southern Circle there are two Divisions to be considered, viz., Chhattisgarh and Nagpur. The cattle of Chhattisgarh are the poorest in the Provinces. They are too small and weak to draw anything but the smallest and least efficient types of implements. The standard of cultivation *in this Division is low in consequence*. The best cattle of the Chhattisgarh breed are to be found in the more jungly zamindaris of the Division such as Bindra Nawagarh and Khariar where there are large tracts of jungle which afford cheap and good grazing. Many cattle are reared in these tracts by *Banjaras*, a nomadic race of professional cattle-breeders. In the Khalsa of the Division bhata plains constitute most of the grazing area; the better land has largely been brought under cultivation. These *bhata plains produce a poor quality of grass, viz., Sukla* or Spear grass (*Andropogon contortus*) and the grazing is exceptionally poor, as the soil is shallow and loses its moisture soon after the rains cease. There is no grazing worthy of the name between December and the middle of July. Despite the fact that grazing is so poor stall-feeding is but little practised. A handful or two of rice straw daily is all they are ordinarily allowed to tide them over the hot weather. As a result of centuries of semi-starvation they have degenerated considerably, except in the jungly tracts already referred to where Nature still meets their wants.

Measures for the improvement of cattle are more urgently required in Chhattisgarh than in any other part of the Provinces. In no Division is improvement more necessary in order to develop cultivation under irrigation. Till his cattle are improved the Chhattisgarh cultivator cannot take full advantage of the enormous scope which will be offered shortly for more intensive cultivation under the larger Government irrigation works. Cultivators complain at present, for example, that their cattle are too weak to puddle their fields for transplantation, and the Department has therefore had to get a smaller but less efficient type of *kopar* and *datari* made in the villages.

There is at *present* only one *Government cattle-breeding farm in Chhattisgarh, viz., the Chandkhuri Farm.* Two more are required, one for Bilaspur and one for Drug. These are urgently needed, but it would be inadvisable to attempt to start them at present owing to the great difficulty of getting suitable cows and bulls. Our present policy is to go on purchasing a few good cows every year for the Chandkhuri Farm so as to get a really good herd there. The other farms required can be stocked from that farm as soon as animals are available.

The site selected for the Chandkhuri Farm was originally a fodder reserve. The area is nine miles from Raipur Farm and is commanded by Kurud *tank which is to be connected up with the Mahanadi. For the last two years* about 20 acres of fodder crops have been grown each year for the herd. It would be advisable to select similar irrigable areas for farms in Drug and Bilaspur. There is a fodder reserve four miles from Drug which would be a very suitable site if it is to be irrigable from the Tendula Canal. I have not inspected any of the likely areas in Bilaspur.

Wherever possible cattle-breeding farms and experimental farms should be combined both for the sake of economy and efficiency. Fodder crops could be raised on the experimental farm for the cattle of the breeding farm; while *the breeding farm* would supply manure for the experimental farm. If cattle-breeding is ever taken up on a large scale, it will be taken up as part of a system of mixed farming.

For the Nagpur Division there is at present one breeding farm on which Gaolao cattle are reared. It caters for the wants of big landowners more especially in Wardha District who have taken up cattle-breeding in their villages and for *Court of Wards' Estates in Nagpur, Bhandara and Chanda Districts. The demand for stud* bulls every year exceeds the supply, though the prices have been gradually raised so that now the young bulls *are sold at prices* which are equivalent to twice their value if castrated. The grazing area of the farm is poor, but it is supplemented by stall-feeding with hay cut within the area, and cheap concentrated foodstuffs obtained locally or imported by rail from the oil mills in the Provinces. The site is a very healthy one, and mortality among the herd is exceptionally low. The total losses this year in a herd of 181 cattle was one cow, one heifer and two calves at birth. The site is central, too, and easily accessible from Nagpur which probably explains the keen demand for our young bulls. *The statement below shows the number of births and deaths for the year.*

	No. in stock on 1st July 1914	Transferred during the year	Births	Total	Sold	Deaths	Lent to the herds of Gaolies' Co-operative Society	
Cows	55	13 heifers now in calf.	..	68	11	1	..	Out of 181 animals 4 died during the year giving a percentage of 2·2.
Bull	1	....	..	1	..	..	..	
Bull-calves	36	8 young bulls from Dairy Farm.	13	62	15	1	1	
Cow-calves	42	....	18	60	1	2	..	
				181		4		

The breeding of buffaloes was started as an adjunct to this breeding farm two years ago; for this purpose the site is not so suitable. Young buffaloes fed largely on separated milk do badly unless they are given good grazing. They are much less hardy than young cow calves. This is very noticeable, too, in *gaolies'* herds all over the country. Of the 12 milch buffaloes purchased by us in Kamptee last month two only had calves. The other ten had died—most of them owing to neglect, no doubt, as it does not pay to rear buffaloes in the neighbourhood of large towns where milk is dear.

I sent up proposals more than a year ago to start a farm on Raigarh plateau for the breeding of milch buffaloes and Gaolao cattle. That tract is one of the very best, if not the best grazing area in the Provinces, I understand, and efforts were made by Government seven years ago to get cattle-breeding started by private enterprise in this and one or two other grazing tracts in the Provinces. The Superintendent, Civil Veterinary Department and I were

sent to Raigarh to report on its possibilities. We now have a great opportunity of taking the lead in the breeding of dairy cattle as we have done in the extension of demonstration work in the Provinces. It would be a great mistake, I consider, to miss that opportunity. My scheme was to rear all our young dairy stock on the plateau. This could be done by keeping the buffaloes there till they have calved. Two-thirds of them could be sent down to the Telinkheri Dairy, while the remaining third could be kept to supply milk for the calves left behind. The buffaloes sent to the dairy would be returned to the Raigarh Farm again when dry.

I had also proposed that a herd of Gaolao cows should be kept on this farm and that breeding on a large scale should be encouraged on the plateau. Gaolao cattle do well there. Many herds are sent there for grazing at present from Nagpur, Chhindwara and Bhandara districts. This scheme was laid before Mr. Low and he had approved of it. It should in my opinion be carried through with as little delay as possible.

The breed of cattle in Chanda is midway in size between the larger cattle of the cotton tract and the puny Chhattisgarhi. They closely resemble the better type of Chhattisgarhi found in Bindra, Nawagarh and Khariar. The grazing areas in Chanda are large and the grazing generally good. It should be possible to improve the herds very much by introducing better bulls. Stall-feeding is already practised in the District. I should like the Chanda breeding farm opened as part of Sindewahi Farm. There is land available. The need of this farm is not so urgent, however, as is that for the other farms referred to.

The opening of a breeding farm for the improvement of Balaghat and Bhandara cattle is not of urgent importance for two reasons :—

(1) the cattle of these two districts are already large enough for the work they have to do and (2) the cattle of this tract are a mixed lot : there is no outstanding type or breed.

In a province like ours where grazing is scanty and where cattle have to be largely stall-fed for part of the year, the most difficult problem we have to cope with in breeding is that of producing sufficient fodder for a breeding farm. Disease is not a serious problem, if the herd can be kept apart from village cattle. On a breeding farm of 100 cattle or so the men in charge may live months without having a single case of sickness to deal with, and without any occasion arising therefore for his utilizing any veterinary knowledge he may have. His agricultural knowledge would be much more in demand. In any case of sickness it is easy, as a rule, to call the nearest Veterinary Assistant. If a breeding farm were to be opened on Raigarh plateau, I would try in that case to get a retired Veterinary Assistant to take charge of it, as the nearest Veterinary Assistant would be far away. There would be no cultivation necessary and a purely agricultural knowledge would not be so necessary.

We may take it therefore that the present staff of the Veterinary Department in the Central Provinces are not in a position to manage cattle-breeding farms efficiently. If we had a strong Veterinary Department and a weak Agricultural staff it would be advisable in that case to choose the lesser of two evils and put the Veterinary Department in charge of cattle-breeding. This was done in the Punjab, I know ; but it was done long before they had any Agricultural Department.

We do not want trained Veterinary Assistants on cattle-breeding farms as a rule, though an exception might be made in the case of farms that are very far away from any Veterinary Hospital.

A cattle-breeding farm should, to start with, consist of a herd of about 40 selected cows and one bull: the number might be increased later to a maximum of about 60. If we start with 40 it will generally be found necessary to replace about one-fourth of them. In the first three years of the farm we may therefore have to find 30 pure cows to take the places of inferior ones which are weeded out and to bring the total number up to 60. This should be done by providing a small sum in the budget every year for the purchase of a few additional good cows for the first two or three years, and by keeping all the best heifers for breeding. By spreading the purchase of the cows over a certain number of years we are likely to get a better herd : the elimination of a few of those purchased in the first year will aways be found necessary.

In three years the herd would amount to about 150 head. For this number of cattle a grazing area of about 250 acres would suffice ; while 150 more would be needed to supply the quantity of hay required, if no other bulky fodder was available for stall-feeding. This is on the supposition that the site is a hilly one like Telinkheri Hill, and that concentrated food also forms part of the diet. Where a cattle-breeding farm forms part of a system of mixed farming, fodders other than hay would be available, and both the hay and grazing area could be reduced. One acre of *juar* may be taken as being equal in value to at least three of hay : and one acre of irrigated land, which could be cropped all the year round, may be taken as being equal to at least 8 of hay.

A cattle-breeding farm run as an adjunct to an experimental or seed farm would require the following staff :—

One Kamdar on Rs. 12 to Rs. 15.

Two herdsmen on Rs. 8 to Rs. 9 each.

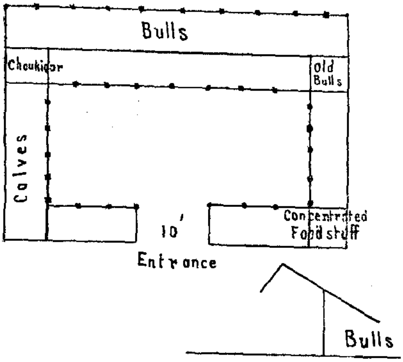
One of the herdsmen would clean the sheds and put the hay and concentrated foodstuffs in the mangers daily. The assistant in charge of the experimental or seed farm would supervise. Cattle-breeding farms should not, as a rule, be run apart from an arable farm, but if that were absolutely necessary, a good kamdar or fieldman on Rs. 20 to Rs. 40 with a knowledge of cattle could run it quite satisfactorily with 2 graziers to assist him as above. He might be given a 6 months' training as a compounder in a veterinary hospital. We are getting a man for Sindewahi Farm trained in this way as there is so much to be done in the way of dressing the wounds of our flock of sheep : but this would not be so necessary for a purely cattle-breeding farm. If the farm were far away from any veterinary hospital, a retired Veterinary Assistant on Rs. 30 to Rs. 40 a month would probably be a useful man as manager. But whoever is in charge he should take a keen personal interest in his herd. He should see that animals which are in poor condition are stall-fed by themselves, and that an animal showing sign of sickness is at once removed to the segregation shed.

A herd consisting of 60 cows, 1 bull and young stock is, I consider, one of suitable size under existing conditions ; but if cattle-breeding were to be taken up in earnest by landowners in any tract, the demand for pure-bred stock would increase very largely, and it would be necessary in that case to double or treble the herd perhaps in order to meet the demand.

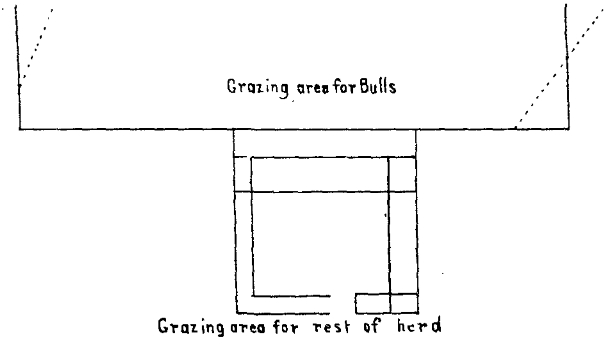
The shed for the cattle should be built in the form of a square with one entrance. One side should be reserved for calves. There should be a small room in one corner of the shed for one of the herdsmen and in the opposite corner for concentrated foodstuffs. A shed 10 feet wide is wide enough. The best type of manger is a semi-circular one of the kind designed for Telinkheri and Sindewahi Farms. The cost of a corrugated iron shed of this type with mangers will amount to about Rs. 50 per animal, big and small, when the work is done departmentally.

The length of shed required can be found by multiplying the maximum number of cows to be kept by four and the number of young stock including calves by two and calling the product feet. An additional shed should be provided for the young bulls of over one year of age, and a small segregation shed for sick animals

The young bulls should each be allowed 10′×4′ and should be tied up at night. The cows and young stock do better if not tied. A very cheap shed can be made for the bulls by extending the roof of one side of the cow-shed towards the outside as shown in the rough drawing below :—



The grazing area on the bull side of the shed should be fenced off for them :—



The cost of starting a breeding farm varies considerably in different tracts. In Chhattisgarh the cost would be approximately as shown below :—

	Rs.
60 cows at Rs. 15 each	900
1 *bull Rs. 60*	*60*
Corrugated iron sheds with additions for 150 cattle	6,000
Segregation shed of brick and tile	500
Quarters *for one grazier* and one *Kamdar*	500
Fencing 400 acres at Rs. 1,200 per mile	4,000
Fencing separate area for bulls	1,000
TOTAL	12,960

The *recurring* expenditure would be approximately as follows :—

	Rs.
1 *Kamdar* on Rs. 20	240
2 graziers on Rs. 7 each	168
Cost of cutting 4 lakhs of *pulas* of hay at R. 0-8-0 per 1,000	200
Carting and stacking charges	250
Concentrated food-stuffs	500
Miscellaneous expenditure on salt, medicines, etc.	100
TOTAL	1,458

For a breeding farm of the Gaolao breed the non-recurring and recurring expenditure would be as follows :—

	Rs.
60 cows at Rs. 50 each	3,000
1 bull at Rs. 200	200
Corrugated iron sheds with additions. The other items as for Chhattisgarh	7,500

The recurring expenditure would be :—

	Rs.
1 Kamdar on Rs. 20	240
2 graziers on Rs. 8 and Rs. 9 respectively	204
Cost of cutting 6 lakhs of *pulas* of grass	300
Carting and stacking grass	400
Concentrated food-stuffs	1,000
Miscellaneous	150
TOTAL	2,294

If run in combination with an arable farm the cost of food-stuffs would be considerably less, and a whole-time Kamdar would not really be required. Moreover a man on Rs. 12 to Rs. 15 working under supervision would do quite well.

These estimates are only meant to be approximately correct. The cost of constructing buildings varies considerably in different places and the standing space allowed for Chhattisgarhi cattle need not be so large as that required for a larger breed. The cost of sheds could be reduced by about Rs. 600 by using a cheap form of manger instead of an iron one as provided for in my estimates. If *kutcha* sheds were constructed, similar to what one finds in villages, the cost would only amount to two or three hundred rupees at most. Under certain circumstances it may be advisable to put up such buildings, but as a rule I take it that *pucca* buildings would be considered preferable to *kutcha* ones.

(e) (iii)

Letter No. 2822, dated Jubbulpore, the 6th August 1915, from G. Evans, Esq., M.A., Deputy Director of Agriculture, Northern Circle, Jubbulpore, to the Director of Agriculture and Industries, Central Provinces, Nagpur.

With reference to your endorsement No. 2109, dated the 8th July 1915, forwarding a copy of the Financial Commissioner's note on the establishment of cattle-breeding farms by Government, I have the honour to submit proposals as requested with special reference to paragraphs 5 and 6 of the said note.

2. As I gathered from the informal conference that was held on this subject at Pachmarhi in June last, the policy of Government is to be the establishment of breeding farms in recognized breeding areas and I am, therefore, assuming that the land acquired for this purpose will consist of light scrub jungle which can be acquired at a nominal figure compared with the price we have had to pay for land for our experimental farms which are situated in open well cultivated tracts where the value of land is high.

3. *Area.* The size of a cattle-breeding farm under these conditions should not be less than 1,000 acres and as it will be more economical to run a few large farms than a number of small ones, the average acreage will probably be about 2,000 acres or so.

4. *Buildings.* Buildings need not be elaborate and might be lean to structures of the type we have on the Powarkhera Farm. They should be made of angle iron and galvanized iron sheeting so that if necessary they can be removed from one site to another without much trouble. The buildings should be constructed in the form of a hollow square so that the cattle can be protected against the attacks of panthers, etc., at night. The other materials which are alternative are :—

(1) Grass thatching and wattle walls plastered with mud which are cheap in the first place but will constantly require replacing.

(2) Brick standards, *cutcha* brick walls and country tile roofs, which again are cheaper than galvanized iron but perhaps not so sanitary and impossible to remove from one place to another.

5. *Size of herd.* The initial herd should consist of about fifty cows and two bulls on an area of some 2,000 acres, which would represent some 200 heads when the herd was fully established. It would include about 200 acres of grass *bir*. This would mean an average of 9 acres per head which may seem a high acreage but it would allow for expansion of the herd to 400 heads and allow 5 acres per beast which is probably a fair rate for much of the inferior grazing in this tract.

6. *Staff.* The staff would consist of one superintendent on Rs. 60 to Rs. 100, a clerk on Rs. 30, one head grazier on Rs. 12 and six graziers on Rs. 6 and Rs. 7. This staff will be necessary as it is proposed to house the cattle at night and stall-feed them with grass supplemented with a light concentrated ration at certain times of the year.

7. *Expenditure.* Non-recurring expenditure would therefore be approximately as follows :—

(1) Buildings of galvanized iron sheeting—

	Rs.
Shed for 60 cows	2,000
Shed for 60 bulls	2,000
Shed for 60 heifers	2,000
TOTAL	6,000

As the prices of materials have gone up recently since the Powarkhera Farm (on which I based my figures) was built and freight will also be much more, Rs. 7,500 may be allowed.

		Rs.
(2) Quarters for superintendent and clerk, etc.		5,000
(3) Cost of two bulls at Rs. 150 each	300	1,800
,, 50 cows at Rs. 30 each	1,500	
(4) Two reapers, baskets, ropes, branding irons, etc.		750
TOTAL		7,550
GRAND TOTAL		15,050

I have not included fencing as this may not be necessary except possibly for the *grass birs*. Rent of land at 4 annas per acre would be Rs. 500.

Recurring expenditure——

	Rs.
(1) Superintendent on Rs. 80 average	960
(2) Clerk on Rs. 40 average	480
(3) One grazier on Rs. 12	144
(4) Three graziers on Rs. 6 and three on Rs. 7	468
TOTAL	2,052
Feed and care of cattle, 200 cattle, for 6 months, hard food 250 Maunds	1,200
Salt, etc.	200
Miscellaneous, office expenditure, repairs, etc.	600
TOTAL	2,000
GRAND TOTAL	4,052

The above estimates are perhaps on the liberal side.

8. *Sites for new Breeding Farms.* A Government breeding farm already exists at Powarkhera Farm and is doing good work although it is not situated in a breeding tract proper.

The main breeding tracts in my Circle are as follows :—

(1) The Rajabarari tract of Harda which merges naturally into the Tapti valley tract of the west of Betul District. Information about the Tapti valley tract is being collected for me by two Assistant Superintendents of Land Records working under the orders of the Deputy Commissioner, Betul (Mr. Wills).

(2) The Tawa valley tract, which includes the large area drained by the Tawa and its tributaries extending east and west from Pachmarhi to Lokhertalai and consisting mostly of light sandy soils with moderate grazing. Many professional *Gaolis* and *Ahirs* breed cattle here and from all accounts the industry is in a bad way. Here again information is being collected for us through Mr. Wills.

(3) The Khamla tract in the south of Betul District where the so-called breed has a reputation for hardiness.

(4) The Kanhan river tract in the north-west of Chhindwara. From what I have seen of the cattle of this tract there is no definite type but cattle raised in this tract have a great reputation in Multai and other parts of Betul and Chhindwara districts and are said to be very hardy and long-lived.

(5) The Jagirs of Chhindwara. Grazing unlimited in quantity. Breeding such as it is in the hands of the *Gonds* is in a very poor state ; cattle are very poor and of mixed breed. Most of the land in these Jagirs is unfit for cultivation but if good cattle are raised, they could be sold at a very handsome profit in the open plains of Narsinghpur and Chaurai to the north and south as the demand is very great.

(6) The south-east of Seoni District in the belt of hilly country from Roomal to beyond Korai. In parts Gaolao cattle would do well.

(7) *Mandla District.*—A certain amount of enquiries have been made and Mr. Nelson has collected a certain amount of information. A large amount of cattle raising is done in a haphazard way by *Gonds* in nearly all parts of the district and the cattle raising industry is a very important one. Bhua Bichhia is said to be one of the most promising centres and a site for cattle-breeding farm has already been provisionally marked down which appears suitable in every way.

(8) The east of Jubbulpore District bordering Mandla.

Another farm for pure-bred Malvi cattle is urgently required as the demand for those bulls from this side is increasing and Jubbulpore people have at present to pay railway freight Rs. 60 or so on a bull purchased from Hoshangabad.

A suitable site could be obtained along the Kundam Road within reasonable distance of Jubbulpore.

(9) Breeding areas also occur in Damoh and Saugor districts where cattle of the Malvi type largely predominate.

I have not mentioned the cattle-breeding tract of Nimar as this district is not now in my Circle, but the question of preserving the old Nimar breed or of raising a good type from its cross with the Khargaou is of immediate necessity.

The other new breeding farms which call for immediate attention are :—

(1) A Malvi breeding farm for Jubbulpore and Damoh districts.

(2) A breeding farm for Ramgarhi cattle in Mandla District.

After these the Harrai Court of Wards offers the best chance of progress.

(e) (iv)

[R. G. ALLAN, M.A., *Principal, Agricultural College, Nagpur.*]

I have but few remarks to make on the Financial Commissioner's note on cattle-breeding farms ; having attended the Conference at Pachmarhi, I am in agreement with most of the points.

I think that Gaolao herd might be moved from Telinkheri and located in a more suitable site nearer Jeytpur in the Sausar Tahsil.

* * * * *

Nimar appears an area of importance and one of the first for a new breeding farm. Here I am of the strong opinion that what should be aimed at is not the keeping up of pure Nimari but the building up of a new breed from the mixed Khargaon and Nimari blood—giving an excellent chance of establishing something good. The essential of the success reached in England in 18th and beginning of 19th centuries largely arose from the mixed character of the foundation stock. Balhar has excellent possibilities and might be considered.

A Veterinary man with an extra year of training in cattle management, breeding and farm work, partly at Hissar and partly here, appears to me the best article for this work. Veterinary knowledge is essential for the

man in direct charge at outside centres—a great deal of the ordinary work is routine work. The noting of points in the stock and the mating arrangements would be the result of the officer-in-charge's orders.

I am of the opinion that these farms are best left in charge of the Deputy Directors of Agriculture throughout their circles. My reasons for this are—

(1) they will be able to see them more frequently,

(2) they are more likely to be in close touch with the local landowners than a single veterinary officer,

(3) cattle and stock-breeding work at home is almost entirely in the hands of landowners or farmers and not veterinarians. I do not mean by this that the control should by any means be of a watertight type as the Deputy Director of Agriculture would be well advised to freely seek the advice of the head of the Civil Veterinary Department.

(e) (v)

[J. H. Ritchie, M.A., B. Sc., *Deputy Director of Agriculture, Central Provinces.*]

Paragraph 3—Cattle Survey of the Province.—The 1910 Cattle Survey is far from being complete and several breeds of cattle have been omitted entirely. These breeds are, however, of the less known types and are used only sparingly in agricultural practice or for other work. In order to bring the Cattle Survey up to date and complete it, I doubt whether the period between now and the end of this year will be sufficient. There are several breeds in Wardha and Amraoti districts which are very little known and about which very little information is available. It will be necessary to visit their breeding tracts and obtain all the necessary information about them. This information will have to be gleaned in the ordinary cold-weather tours, and unless it is absolutely essential to have all the information acquired before the end of the present year, I would suggest a postponement of the period till the end of March, by which time all the districts will be visited by me and information collected.

The different breeds of buffaloes were omitted from the 1910 report and they should be included in the revised one.

Paragraph 4.—The chief breeds of cattle in the Division of Berar and the districts of Nimar and Wardha may be taken as follows :—

(1) Gaolao in Wardha District.

(2) Umarda in East Berar.

(3) Khamgaon in West Berar.

(4) Nimari and Khargaon in Nimar.

The Gaolao breed is being reared at Telinkheri and there is no need to start another breeding farm in the district where they have their home, although in the Arvi Tahsil of Wardha District some very suitable places could be found for a breeding farm.

The Umarda breed which is indigenous to East Berar deserves attention by the Department. It is hardy and strong and specially suited for agricultural work, much more so than the higher and longer-legged Gaolao which is better suited for the faster and lighter work on roads. This breed could be satisfactorily dealt with in its native haunts, especially in Yeotmal District or in the Arvi Tahsil where good grazing facilities abound. It is difficult to say at present whether there is any likelihood of a vigorous demand springing up for bulls, but I should think that there is every probability of all stock being disposed of to private individuals in the Wardha District. Cultivators in Berar pay high prices for bulls and they already know the benefits of using good bulls for breeding purposes, so that I anticipate no difficulty in getting the animals sold. Encouragement to start private breeding farms will be given by the Department especially to members of Unions and Agricultural Associations. Good animals will always fetch big prices and the demand for good bulls is always large.

As regards paragraph 3 of section 4 of the Financial Commissioner's Note, the only existing breeding farm in the Western Circle is admirably suited for the purpose it fulfills. When the farm has run sufficiently long for us to be in a position to sell off bulls and heifers, a demand for these will be created by the Department. Every Agricultural Union will be induced to possess a bull for the use of its members, and there is a sufficient number of members in the different Associations intelligent enough to know the value of good stock and who will readily start private breeding farms.

Section 5.—The area of a breeding farm must depend entirely on the grazing available and the size of herd to be maintained. It would be absurd to lay down any fixed area per head of cattle or to say that so many acres of pasture at Telinkheri should support the same number of cattle at Borgaon. The quality of the grass comes into play and there is no comparison between the richness of the fodder found at Telinkheri and at Borgaon. At the former it is mostly Sukla (*Andropogon contortus*) while at Borgaon the grass is mainly Pohna (*Ischæmum sulcatum*) which is the most nutritious grass in the Central Provinces and twice as rich as the other. Moreover, it can be grazed during the whole season, while Sukla is useless after the fruits set and the "spears" become hard. Cattle refuse to eat it at this stage, and it is only when the "spears" fall or are removed by artificial means that an area of spear grass is fit to support animal life. Sukla takes a long time after the rains break to attain a sufficient height for the cattle to catch hold of it. In other words, it is a very slow grower to start with. Pohna, on the other hand, soon sprouts up after rain and in the shortest of time the land is covered by a green carpet of grass.

About 1 acre of good grass per head should be allowed for grazing. This is the area allowed in Great Britain for dairy and breeding herds and should be quite sufficient for actual grazing in India. Another acre per head should be allowed for cutting and storing for use in the hot weather months and in case of the failure of rains in any year. This gives a total of 2 acres per head, and it will be seen that this is approximately the area of the breeding farms in the Central Provinces.

The buildings required are :—

(1) Cattle shed of galvanized iron with separate compartments for cows, stud bulls, heifer calves and bull calves.

(2) Dutch barn for storing grass.

(3) Segregation shed of brick and lime. (Galvanized iron would be too hot for animals kept tied up during the hot weather days).

(4) Small cake godown.

(5) Superintendent's quarters ;

(6) Four servants' quarters, to which might be added a room for keeping medicines and essential veterinary appliances.

(7) A small rest house for officers would also be necessary if the place was remote from a headquarter town.

To start a Government breeding herd, 40 cows should be selected and 2 breeding bulls. By employing 2 bulls with the herd the standard of excellence, which should be aimed at in all breeding operations, will be reached much

earlier. No bull possesses all the points which it is our aim to secure, and by mating with cows which are also defective in the same points, the fault is only aggravated in the offspring and no improvement is achieved. By employing 2 bulls which differ in the strength of the characters we wish to bring out in our offspring and mating them with cows which are weak in those characters, our ideal animal will be reached in half the time. This means dividing the herd into two portions, those strong in one important character in one half, and those weak in that character but strong in another in the other half. Twenty cows to one bull is about the best ratio for successful breeding.

The staff required for a breeding herd should consist of one Superintendent, four graziers and if fodder crops are to be grown two ploughmen.

Estimate of recurring and non-recurring cost.—The buildings including wire fencing could be erected at a cost of from Rs. 12,000 and Rs. 13,000.

	Rs.	
Purchase of animals	2,300	
Recurring annual labour expenditure	600	including 4 graziers at Rs. 10 per mensem.
Feed of cattle	800	
Miscellaneous	200	
TOTAL	1,600	

Section 6.—Breeding farms should, in my opinion, be under the direct control of the Deputy Directors of Agriculture. Breeding in Britain is done by practical farmers and not by Veterinary Surgeons, many of whom are perhaps good judges of horses but know very little of cattle. Agriculturists, on the other hand, generally know more of cattle than of horses, because practically every farmer nowadays goes in for breeding, either commercial cattle, dairy cattle or pure stock.

The superior subordinate staff should, I think, consist of Agricultural Assistants, who in their agricultural college course increase the knowledge of cattle which they should previously have known. Besides, the short course of lectures which is included in the college course is all that is required for the treatment of the bruises and wounds which all cattle are liable to receive. For diseases, epidemic and otherwise, it is an easy matter to call in a Veterinary Assistant for inoculating the herd if necessary, and even then this operation does not necessarily require one, because it is the simplest matter in the world to do. As regards employing a Veterinary Assistant with a post-graduate course in cattle-breeding, I may point out that cattle-breeding is a subject which cannot be learnt from books but must be acquired by practice. I don't see the necessity at all for any post-graduate courses either in cattle-breeding for Veterinary Assistants or in veterinary science for Agricultural Assistants. The Assistant will be in charge for management only. The cattle will be bought by the Deputy Directors of Agriculture in conjunction with the Superintendent, Veterinary Department, if necessary, and everything will be carried out according to rules laid down by the Deputy Director of Agriculture.

The Veterinary Assistant of the District should include the Breeding Farm in his rounds every month and in case disease breaks out should be early on the scene to render help. The Deputy Superintendent and Superintendent, Veterinary Department, should visit each farm at least once per year and make any suggestions in writing to the Agricultural Officer in charge of the Circle. The Veterinary Department have not the staff nor the supervision that is necessary for running a breeding farm successfully.

(e) (vi)

[S. G. M. HICKEY, I.C.V.D., *Officiating Superintendent, Civil Veterinary Department, Central Provinces.*]

Existing Cattle-breeding Farms. All the existing cattle-breeding farms are well situated with the exception of the Telinkheri Cattle-breeding Farm and Dairy which have from time to time been found to be the seat of infection resulting in a heavy loss of cattle and sheep. I would, therefore, suggest that this farm and the Government portion of the Dairy be closed at an early date, and a new farm started for the Gaolao breed at a more suitable site elsewhere in the Nagpur District, which can be determined when the Cattle Survey undertaken by the subordinates of this Department is completed.

2. *Model Cattle-breeding Farms.* Major Baldery was in favour of the establishment of District Cattle-breeding Farms with 20 head of cattle and one bull each to start with ; but as this was considered to be on too small a scale to meet the demand, I would suggest that in a model farm the initial herd should consist of 60 cows and 3 bulls. The acreage of land required for such a farm would of course vary from district to district depending upon the feeding value of the pasture. I would allow 7 to 10 acres per head. At this rate about 1,000 acres of land would be required so as to allow for expansion of the herd. The Farm buildings and sheds should occupy an elevated position so as to allow of free drainage, and there should be a plentiful supply of water near at hand.

Sheds. The shed for housing the herd should be constructed of galvanised iron sheeting and comprise :—

(1) (*a*) a compartment for cows,

(*b*) a compartment for male yearlings,

(*c*) a compartment for female yearlings, and

(*d*) a compartment for stud bulls.

(2) There should be a separate shed divided into :—

(*a*) a compartment for working cattle,

(*b*) a compartment for bulls above one year of age, and

(*c*) a compartment for storing oil-cakes, cotton-seed and concentrated food stuff ;

(3) a third shed for storing fodder for night consumption and to meet straitened conditions in times of scarcity of fodder ;

(4) a fourth shed outside the farm area built of such materials as would stand disinfection by fire or chemicals and capable of accommodating ten animals to serve as an isolation ward for diseased animals ; and

(5) a Dutch barn for the storage of fodder for consumption during the hot weather.

Buildings. There should be *pucka* buildings for the accommodation of the Farm Superintendent, with a room for dispensing medicines and for keeping medical stores and quarters for the attendants. The supervising establishment should consist of :—

3 to 5 graziers on Rs. 10 per mensem each,

3 to 5 labourers on Rs. 8 per mensem each,

1 Mukaddam on Rs. 20 per mensem, or

1 Compounder on Rs. 20 per mensem,

1 Officer in charge on Rs. 70 per mensem.

The non-recurring and recurring charges that will be entailed by the above staff, buildings and shed are as follows :—

Non-recurring charges.

	Rs.
Land 1,000 acres	30,000
Buildings and sheds	20,000
Wire fencing	2,000
Wells	2,000
Agricultural implements	500
Working cattle	500
Veterinary instruments	300
Breeding cows	3,000
Bulls	750
TOTAL	59,050

Recurring charges.

Repairs to buildings at 3 per cent. on capital cost	600
Establishment—per annum	2,500
Wages and other labour	1,500
Medicines and instruments	300
Feed of stock	1,500
Purchase of stock, etc.	300
Contingencies	500
TOTAL	7,200

The Farm should, in my opinion, remain as at present under the direction of the Deputy Director of Agriculture, in whose Circle it would be located, but should be inspected periodically by the Superintendent, Civil Veterinary Department, Deputy Superintendent of the Division and the District Veterinary Inspector and be manned by a fairly senior Veterinary Assistant who has undergone a post-graduate course in cattle-breeding (say a 6 months' course at the Hissar Farm, Punjab) and a short course in bacteriology and parasitology. With the present facilities instruction in the latter course can be imparted at the new Veterinary Laboratory at Nagpur.

Agricultural Assistants know only the rudiments of veterinary science and would have to undergo the usual three years' course in veterinary science to be competent to treat sick cattle.

It will thus be seen that it is much easier to train a veterinary assistant in the rudiments of agriculture and breeding than to train an Agricultural Assistant in veterinary science. Besides it is essential that cases of sickness at the Farm should be promptly attended to and any epidemic that breaks out in the herd suppressed with the least possible delay. This can only be done by a Veterinary Assistant possessing a thorough knowledge of veterinary science. For these reasons I have suggested that the man to be kept in charge of such a Farm should be a fairly senior Veterinary Assistant.

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(9)

ASSAM.

(a)

Note on Food and Fodder Supply.

[A. G. BIRT, B.Sc., *Deputy Director of Agriculture, Assam.*]

In this Province the practice of growing fodder crops for cattle is practically non-existent at present outside the Government farms. For bulky food the cattle have to depend on refuse from the threshing floors and on what they can pick up by grazing on waste land and on the paddy stubbles.

With regard to concentrated food, people who keep cattle for carting feed them on a little oilcake and rice or pulse occasionally, but this practice is not common among the cultivating classes.

The matter may be summed up in the statement that the great majority of cattle in Assam have to depend entirely on what they can pick up for themselves.

The lack of sufficient grazing lands has been put forward as an explanation of the poor type of cattle to be found in Assam to-day ; but with the exception of a few thickly populated districts, where all the land not taken up for rice goes under deep water, Assam is better off for grazing than many provinces where the cattle are of a very much superior type. Indeed it appears that the existence of considerable areas of waste land which can be used as common grazing grounds tends to be detrimental rather than beneficial to the breed of cattle.

I am aware that this statement is opposed to the popular theory that the cure-all for the cattle problem in this country lies in the extension of grazing areas, but the fact has to be faced that, although in the greater part of Assam grazing conditions are more favourable than in other parts of India, yet our cattle are some of the worst to be found in this country

The existence of large areas of waste land results in the people keeping far more cattle than they actually require, and these roam about in larger mixed herds which are not kept under proper control, resulting in promiscuous mating of young and immature animals. Again, in the presence of sufficient grazing to keep the animals alive at all seasons of the year the cultivator does not see the necessity for feeding any concentrated food or for growing fodder crops. If a few of his animals die of disease or are killed by wild animals he is inclined to take it philosophically since they have cost him very little to keep, and he has usually others to fall back upon.

It is not suggested that grazing grounds are non-essential for cattle breeding, but in cases where grazing cannot be relied on for the entire support of the cattle, the cultivators are forced to grow fodder crops and to do a certain amount of stall feeding, and this leads to more value being placed on their animals, with the result that the cattle get more attention both as regards feeding and breeding.

Under present conditions then it appears to be hopeless to attempt to push fodder crops in the greater part of the Assam Valley ; and until pressure of population forces the people to adopt more intensive methods of farming very little can be done.

In Sylhet and portions of Kamrup and Goalpara districts the conditions are different. The greater portion of Sylhet goes under water for several months in the rains. The district is thickly populated, and almost every acre that will grow rice is cultivated. The consequence is that in the rains the cattle are cooped up on a bit of land near the villages or picketed to graze on road and railway embankments. About the only food they get is some coarse and watery *bhil* grass and some very coarse paddy straw. It is a common thing in the rains to see cattle standing up to their hocks in water. On the other hand during the cold weather when the water has gone down and the crops have been harvested, the cattle have a good time. The *bhil* sides are covered with a fine growth of *dub* grass which springs up on the mud, and this together with pickings from the paddy stubbles keeps them in good condition. What is needed, therefore, in Sylhet is a fodder crop to carry the cattle through the rains, and this could be managed fairly easily, provided the cultivators were willing to devote a small area of higher land near the village sites for the growth of *Jowar.*

In Kamrup and Goalpara there are also thickly cultivated tracts where a fodder crop could usefully be introduced. A start has been made this year in Kamrup with *Jowar*, which has been demonstrated in several centres. It now remains to be seen whether a demand for *Jowar* seed for sowing for fodder can be created.

(b)

Note on cattle breeding.

[W. Harris, *Superintendent, Civil Vety. Dept., Assam.*]

In Assam there are no fine breeds of cattle similar to what is found in other provinces. The cattle are small and often poor and wretched.

The chief reasons for these conditions are :—

1. Insufficient supply of suitable fodder all the year round.
2. Neglect or want of proper treatment of young stock.
3. Errors in breeding—
   (*a*) breeding from immature stock,
   (*b*) in and in breeding,
   (*c*) want of selection of the best animals and sterilization of the weeds.

In many parts during the rains the cattle stand continuously in mud and water and are fed on nasty rice straw and weeds which grow in swamps. This is not a suitable condition for cattle though it suits buffaloes alright. Cattle on inundated lands are very liable to become infected with certain parasitic diseases which cause anæmia and emaciation. No important improvement in the breed can take place in low-lying areas, no matter what steps are taken. On suitable land with sufficient food and care the present breed of cattle would vastly improve. Importation of bulls from other provinces would more rapidly increase size, bone and power. A scheme for the importation and distribution of Manipuri bulls has been sanctioned. A difficulty in the past has been to get suitable bulls. This scheme should greatly help to overcome this difficulty. At the present time the calves are small at birth and often weeds not worth rearing.

The cow is not fit to carry a calf and often has not sufficient milk to rear it, even if man does not take any. This stunts the growth of the animal and it remains small.

On this subject one of the first questions to ask is what does the ryot want. The ordinary cultivator seems to be quite happy with his herd of small animals, and unless disease and deaths are very busy he has more than are necessary to do his work. Many ryots really keep too many cattle in comparison with the available food supply and amount of work required. He does not want big cattle. Experience has shown he will not bring his cows a mile to the Government bull. There is no doubt that better milking animals are wanted and also strong animals for cart work. The milking qualities of the present animals are undeveloped because of improper food and improper treatment of the milk gland. Plenty of succulent food and proper milking methods are necessary. Given these the present breed would greatly improve.

For cart work fairly big strong animals are necessary, bigger than the indigenous breed. Carters import their animals from Bihar districts. Each year the price increases as animals are more difficult to obtain. It does good by teaching the carter to take more care of his animals, a lesson which he badly needs. Regarding this question of cattle improvement I think one of the important steps should be the rearing of healthy calves from suitable stock of the present breed, under conditions which would ensure their developing as far as possible ; these animals should then be selected for breeding. In course of 2—3 generations the results would show the possibilities of the present local animal. The question of further improvement could then be decided. I am convinced that the placing of even a dozen good bulls in a district (instead of one) is only a very temporary advantage until the ryot learns more about stock raising and wants to improve his stock.

[A. G. Birt, B.Sc., *Deputy Director of Agriculture, Assam.*]

This question has been kept pending the receipt of Mr. Blackwood's report on cattle in Assam. In the meantime a proposal, from Colonel Raymond and Mr. Harris, to start a large cattle breeding station in the North Cachar Hills has been considered. Mr. McSwiney and I visited Haflong at the beginning of March 1914, but failed to locate a suitable site for a cattle-breeding station. I understand that the Sub-Divisional Officer, Haflong, is on the look-out for a suitable site and will communicate with us soon as he has found one.

The whole question of the improvement of cattle and the milk supply in Assam is extremely difficult, and great caution should be exercised in giving effect to any schemes. Judging from our experience at Shillong it seems very improbable that the ordinary cultivator will be prepared to purchase and support superior bulls for the improvement of his cattle. Even the Khasi, who is more progressive as a rule than the plains man, is reluctant to invest money in bulls, although the price has been fixed at Rs. 50 which is only about ¼ the value of a bull. At the present time I consider that the improvement of cattle by the individual cultivator is almost out of the question. Some agency is required to keep and control the services of stud bulls and at the same time to see that inferior village bulls are not allowed to roam about and serve cows indiscriminately. The practice of sending out a few bulls to Local Boards, as has been done to some extent in the past, is futile, as a Local Board bull is the bull of nobody in particular and often gets neglected. In any case the few bulls sent out are merely a drop in the ocean. A very much wider agency than that of the Local Boards is therefore required, and in considering what agencies should be employed I would put the tea planter first. The coolies in the vicinity of a tea garden usually keep a considerable number of cattle which can be *fairly easily controlled* by the planter, and if he were supplied with a sufficient number of bulls of the right type, the improvement of cattle in the vicinity of tea gardens would only be a matter of time, always provided that attention be paid to feeding which is of the utmost importance in the improvement of live-stock. However good the bulls may be, you will never get good working or milking animals out of half-starved cows.

With regard to other agencies—in the permanently settled districts (Sylhet and Goalpara) the best agency available is the Zamindar if be could only be stirred up to take an interest in the subject; and in the non-permanently settled areas something might be done through the *Mauzadars*, and later on as the scheme develops, eventually through the *Gaonburas*.

The type of animal required in Assam is a dual purpose animal, the cows of which would be good milkers and the males good draught animals. I do not think there is any need to attempt two distinct types, one for milk and the other for draught. It should be possible to combine these two qualities in the same breed. In Great Britain the Shorthorn breed is famous both for milk and beef, and so far as I can see there is no reason why milk and draught should not be combined in the same way.

A point needing thorough investigation is whether improvement should be attempted simply by rigid selection of indigenous cattle, or whether crossing with exotic breeds should be resorted to. Personally I favour selection of the best of the indigenous cattle, although crossing would probably effect a more immediate improvement.

On whatever lines it is decided to work, one thing is essential, *viz.*, that the breeding of bulls should be taken up on an extensive scale and pushed vigorously. One farm in the North Cachar Hills will only touch the fringe of the question. It should be regarded in the light of an experiment, and if successful at least one farm for every distinct tract should be maintained. This will entail a good deal of expense, as the farms will certainly not be self-supporting until the public are in a position to pay the real value of the bulls sent out; but if any impression whatsoever is to be made on the cattle of this province, operations must be carried out on an extensive and, I fear, expensive scale.

With regard to dairying I do not think the time is ripe to consider the manufacture and disposal of milk products. What is required at present is larger and cheaper supply of pure milk, and this can best be secured by increasing the milking capacity of the cows.

[A. R. EDWARDS, I.C.S., *Director of Land Records and Agriculture, Assam.*]

A scheme for importing through the Political Agent, Manipur, 50 selected Manipuri bulls towards the end of this financial year has recently been sanctioned. It is intended to supply them, at a small price, subject to certain conditions, to such tea planters and others as are likely to see that good use is made of them.

The scheme is intended to be experimental; whether work on similar lines will be continued in future years will depend mainly on how far it proves to be a success. If the Political Agent, Manipur, is able to improve the Manipuri stock by cross breeding he hopes to be able to supply the improved stock in place of the pure Manipuri.

Full details of the scheme have not yet been worked out. Mr. McSwiney was of opinion that in view of the Manipur scheme, that for a cattle-breeding station in the North Cachar Hills should probably be dropped. The Sub-Divisional Officer is also doubtful whether the proposed site would be suitable. The matter will be finally considered after receipt of Mr. Blackwood's report.

(10)

BURMA.

[H. CLAYTON, I.C.S., *Director of Agriculture, Burma.*]

The position of the Agricultural Department with regard to cattle-breeding in Burma may be seen from the following resolutions passed at the Half-Yearly Conference of the Department held in June last when the following resolutions were unanimously passed:—

(*a*) That the introduction of foreign breeds of cattle for breeding purposes into Burma is undesirable, until such time as the result of crossing such breeds with the indigenous cattle of the Province has been carefully studied and demonstrated by means of experiments under close supervision.

(*b*) That the only effective method of placing the breeding and improvement of Burma cattle on a satisfactory basis would be the establishment of a breeding farm under the control of the Department and the creation of a pedigree herd of the Burma breed, and that it is desirable that work on these lines should be undertaken as soon as funds permit. Similar resolutions were passed at the Provincial Agricultural and Co-operative Conference held in August 1915 when in addition to the representatives of all the Co-operative Societies of the Province, a large number of officials and others interested in agriculture were present. This Conference added that it was desirable that the farm should be under the management of the Agricultural Department with the assistance of a Committee of Burmans interested in cattle-breeding, and that pedigree bulls from the farm should be sold to co-operative societies.

There is thus a general consensus of opinion among the cultivators, officials and experts of the Province that the existing breed of Burman cattle is that most suited to the Province and its requirements and that all that is required is its improvement by selection and scientific breeding. The proposals of the Department and of the Provincial Conference with regard to a departmental cattle farm will be brought to the notice of Government when proposals are next submitted for an expansion of the work of the Department.

Food and fodder supply. Speaking generally the considerable and in some tracts extremely large amount of unclassed forest and other waste land still available has caused the question of cattle food and fodder supply to be of but small importance. The practice of the stall-feeding of plough animals is common in many tracts and is increasing. Fodder crops of which *Sorghum vulgare* is the most important are grown largely in the dry zone where fodder is most frequently deficient. The very large outturn of sesamum in the Province enables sesamum cake to be freely used as cattle food, and one of the chief objects of the present policy of the Agricultural and Co-operative departments in endeavouring to encourage the establishment of power oil presses run by co-operative societies or other rural agencies is to secure that a larger proportion of this cake than heretofore shall be made available as fodder for the cattle of the cultivators on whose lands the sesamum is grown.

Grazing grounds have in the past been freely reserved in Lower Burma, but the advantages or disadvantages of them are still in dispute and the question is still to some extent under consideration. One of the disadvantages confronting the cultivating owners of cattle in Burma is the large herds kept in many tracts by non-cultivators, more particularly natives of India. These herds not only consume a good deal of cattle fodder which would otherwise be available for the cultivators of the land on which they are herded, but also, being badly looked after, frequently prove disastrous disseminators of disease. The Provincial Conference passed the following resolution on this subject: "That the existence of large herds of badly bred cattle kept for milk and similar purposes by owners who are not *bonâ fide* cultivators is a daily increasing menace to the health and well-being of the indigenous breed and to the interests of the cultivators who pay the land revenue, and that measures are urgently needed to control the evil by way of taxation, prohibition or segregation to particular areas. The Conference will be grateful to Government if they will deal with the evil on some such basis." The question is now being examined in consultation with district officers with a view to discovering the exact extent of the evil and the most suitable measures for its suppression or control.

(11)

SIND.

Extract from a Letter No. 767 G-VI-3, dated 23rd July 1915, from the Superintendent, Civil Veterinary Department, Sind, Baluchistan and Rajputana, Karachi, to the Commissioner in Sind, Karachi.

With reference to Government Order, Revenue and Agriculture, No. 7163, dated 2nd July, 1915, I have the honour to submit the following notes on "Cattle-breeding and Food and Fodder Supply" in Sind.

Taken as a whole Sindhi cattle *are of poor quality; but the* people appear satisfied with them, and until they desire a better class of animal and grow fodder crops, I do not think that any attempt to improve cattle in Sind is likely to meet with much success.

I understand that there is a breed of cattle identical with or very similar to the Bhagnari breed of Baluchistan *in Ghaibi Dero Jagir in the Larkana* district. A lot of these cattle were bought and probably are now by Punjabi dealers, but Sindhis do not often buy them. I have seen some very good cattle, showing Hissar or Bhagnari blood in the Jamrao Canal Colony. Most of these cattle are owned by Punjabi cultivators. Apart from these two instances, Sindhi plough cattle are poor, but, as I have said above, their owners are satisfied with them.

The question of improving and conserving the well known Karachi breed of milch cattle is under consideration.

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(12)

AJMER-MERWARA.

Letter from the First Assistant to the Agent to the Governor-General and Chief Commissioner, Ajmer-Merwara, No. 2186 – 1073, dated 4th November 1915.

I am directed to acknowledge the receipt of your letter No. C-140—4, dated the 15th June 1915, regarding the preparation of notes on "Cattle breeding and Food and Fodder Supply" in Ajmer-Merwara, and in reply to state as follows :—

2. An attempt in the direction of improving the breed of cattle in Ajmer-Merwara was made a few years ago and bulls were maintained for this purpose at various places in the district. This attempt has now been abandoned in accordance with the recommendation of the Superintendent of the Civil Veterinary Department in Sind, Baluchistan and Rajputana, as no appreciable measure of success had been attained. The main reason which led to the failure of the movement was the inadequacy of the veterinary staff. Cattle breeding, as the Superintendent, Civil Veterinary Department pointed out, is a delicate operation which requires constant expert supervision if it is to produce satisfactory results. In Ajmer-Merwara there are only three veterinary assistants and their work is mainly confined to the urban centres of Ajmer and Beawar. There is only one Superintendent for Rajputana, Sind and Baluchistan. Consequently this officer can only spend a very limited portion of his time in supervising the work of his subordinates in Ajmer-Merwara. It was therefore considered that it would be wiser to postpone the attempt at encouraging cattle breeding until such time as the veterinary staff might be adequate to deal with the problem efficiently rather than to continue an unpopular and unsatisfactory scheme which would only serve to prejudice the minds of the people against all future endeavours in this direction.

3. As regards fodder supply, Ajmer-Merwara suffers in a majority of years from an inadequate rainfall and a deficiency of fodder is consequently not infrequent. In good years there is an ample supply of grass and efforts are made to induce the people to put by a sufficient store to provide against a period of scarcity. Great difficulty has however been experienced in persuading the people to do this owing to their thriftlessness and the scarcity of labour in a good agricultural year. Hence the stocks of fodder have always proved insufficient in a year approaching famine conditions, and, though a certain amount of fodder is imported from outside, a large number of cattle invariably migrate to pasture beyond the limits of the district.

The revenue rules of the district already provide encouragement to the cultivators for growing fodder crops, and it is hoped that, where co-operative societies with adequate capital exist, they may be induced to take up the question of ensilage and the cutting and storing of grass for hay. The results of any experiments made in this direction by the Board of Agriculture will be eagerly awaited in this district.

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(13)

COORG.

[G. HALLER, *Deputy Director of Land Records and Agriculture, Coorg.*]

Although the physical features and climatic conditions of this province vary from 500 to 4,000 feet elevation and from 40 to 200 inches rainfall per annum respectively, good cattle are found in all parts of Coorg ; but the live-stock, taken as a whole, is of very inferior quality. It is then clear that the climate is not unfavourable to cattle-breeding ; and that a great deal depends on the farmers themselves. Cattle-breeding is successfully carried on in the eastern parts bordering Mysore where the villagers maintain *jointly a breeding bull ; elsewhere, a few well-to-do* land-holders keep their own bulls.

2. The local breed itself is of a very useful type for ploughing and excellent animals are at times found amongst such cattle. The stock could therefore be improved, if attention were paid to selection of the fittest. But, unfortunately, immature bulls, the offspring of a degenerated stock, are allowed to serve cows promiscuously. The recent *rise* in the price of cattle has, in a small degree, had the salutary effect of teaching the careless to pay more attention to cattle-breeding.

3. As regards improving the existing live-stock, I consider that, unless the raiyats themselves castrate all unfit male calves at the earliest age, preserving the best for breeding, it is hopeless to expect satisfactory results. The Veterinary Department is doing all that can be done in advising them. The distribution of bulls by Government did not prove a success, partly because the people to whom they were given kept them for their own purpose and partly on account *of the difficulty of* finding suitable cows for them. Bulls from other districts have to get acclimatised and in consequence go down in condition. Moreover, unless proper attention be paid to eliminate all unsuitable bulls, all attempts at improvement by imported bulls are bound to be a failure.

4. It is also undesirable to have too big animals, as they are not very useful for ploughing purposes. The main object should be directed towards raising suitable ploughing cattle. All this indicates that we should rely, as far as possible, on our own resources, and that every inducement should be given to the raiyats to improve their cattle from the existing stock by castrating, as early as possible, unfit calves and retaining only the soundest animals for breeding purposes. In order to do this, I would suggest that rewards be offered for the best bulls, cows to be excluded, provided that other conditions be also fulfilled: stabling, castration of all unfit calves and general appearance of the cattle. *The payment of the rewards should be conditional on the results of a local examination of the* farmers' cattle; such examination might be entrusted to reports in prescribed forms by subordinates of the Revenue Department, and as far as possible by the Veterinary Department.

Food and Fodder Supply.

5. The question relating to food and fodder supply has been raised from time to time in this province. [illegible]

6. In 1886, then in 1892, trials were made with silos by the Forest Department but have been abandoned as unsatisfactory. *The main cause for failure was the want of a suitable kind of grass. Since the last [illegible] years a* coffee planter. Mr. Percey G. Tipping, started ensilage on his estate with great success. Mr. Tipping [illegible] guinea grass which is admirably suited for the purpose as it grows to a height of 4 to 6 feet. The silos are [illegible] during the monsoon. In the dry weather, when fodder is scarce, the pits are opened. Cattle are very fond of this fodder and thrive very well on it. As it is essential that the pits are filled with the least possible delay, it is imperative that large quantities of grass are readily available. This is not possible unless land is specially reserved for fodder, which unfortunately no one does in Coorg, where cattle continuously graze over the same land and in consequence suitable quantities are not available.

7. As regards guinea grass Mr. Tipping is of opinion that it is more wholesome after having been stored in a silo.

8. It seems marvellous how the cattle survive the dry weather in this province, where from March to May not a blade of green grass is available in large tracts. I have observed, however, that they mainly, if not entirely, subsist during these months on leaves from certain trees and shrubs, which they seem to prefer to grass, even where it is available.

9. I believe, *therefore, that the planting of suitable trees and shrubs* should be encouraged in countries where fodder is scarce.

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